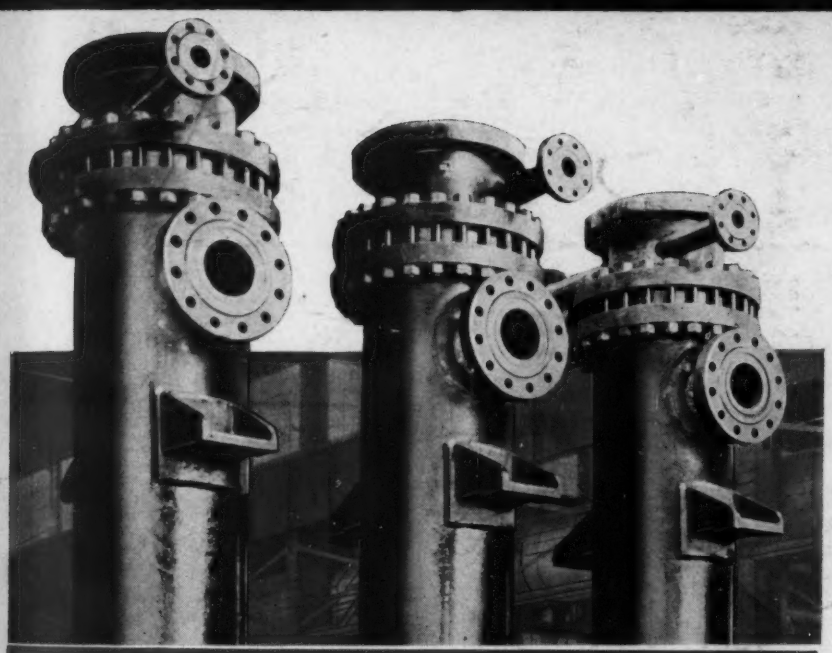
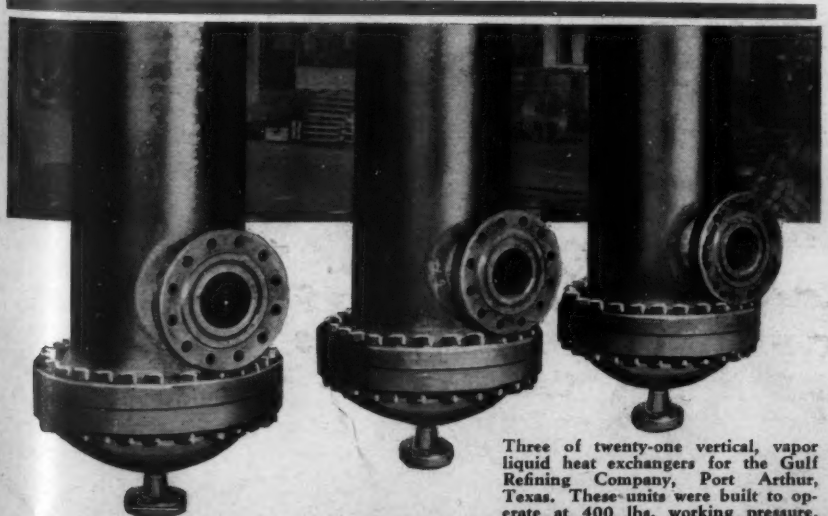
The REFINER AND NATURAL GASOLINE MANUFACTURER



High Pressure Heat Exchangers



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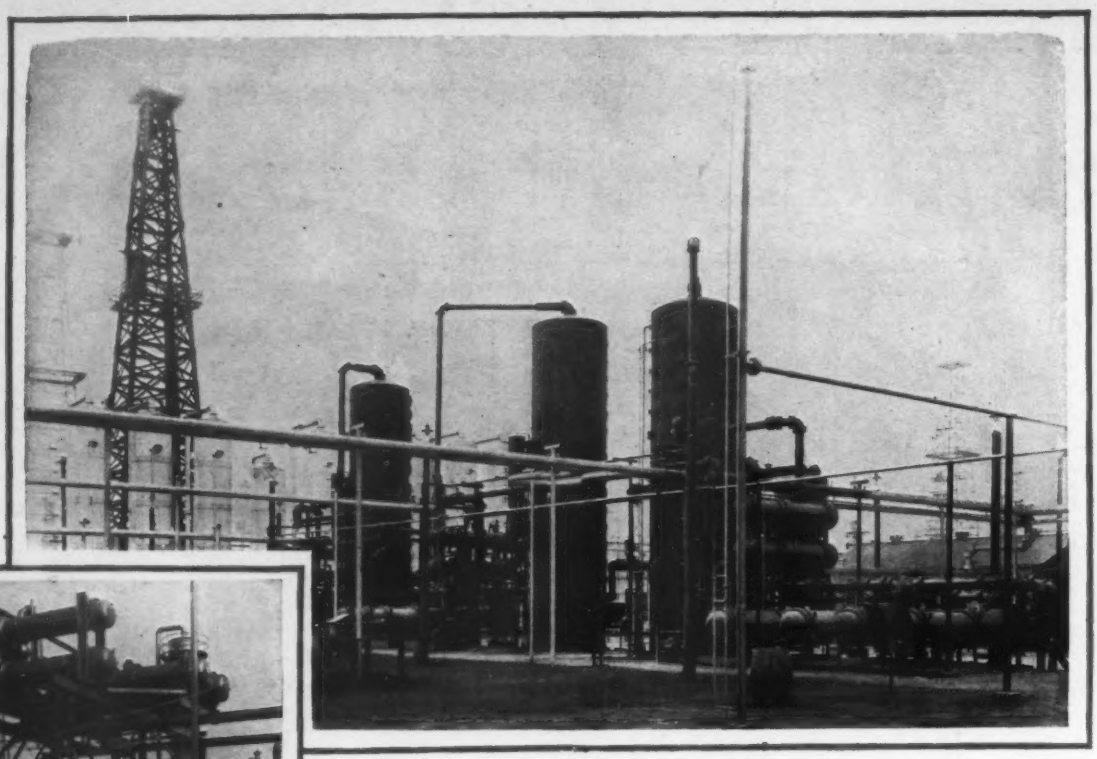
BRAUN ABSORPTION PLANTS



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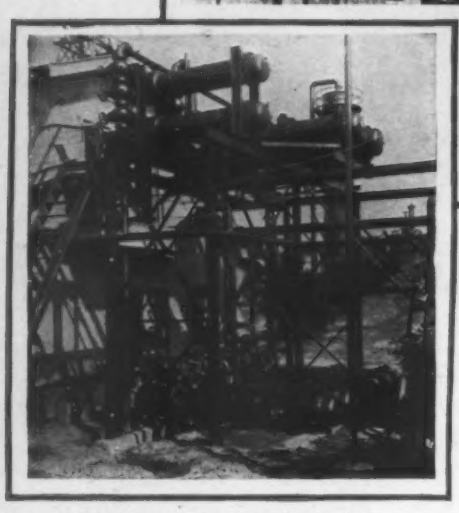

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A Gulf Publishing Company Publication

THE REFINER

and Natural Gasoline Manufacturer

Member Audit Bureau of Circulations

VOL. 9, No. 9 — SEPTEMBER, 1930

GRADY TRIPLETT, *Editor* — GEORGE REID, *Associate Editor*

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EDITED MONTHLY AT TULSA, OKLAHOMA
Copyright, 1929

Published Monthly
by
GULF PUBLISHING COMPANY
OFFICE OF PUBLICATION
3301 Buffalo Drive, Houston, Texas

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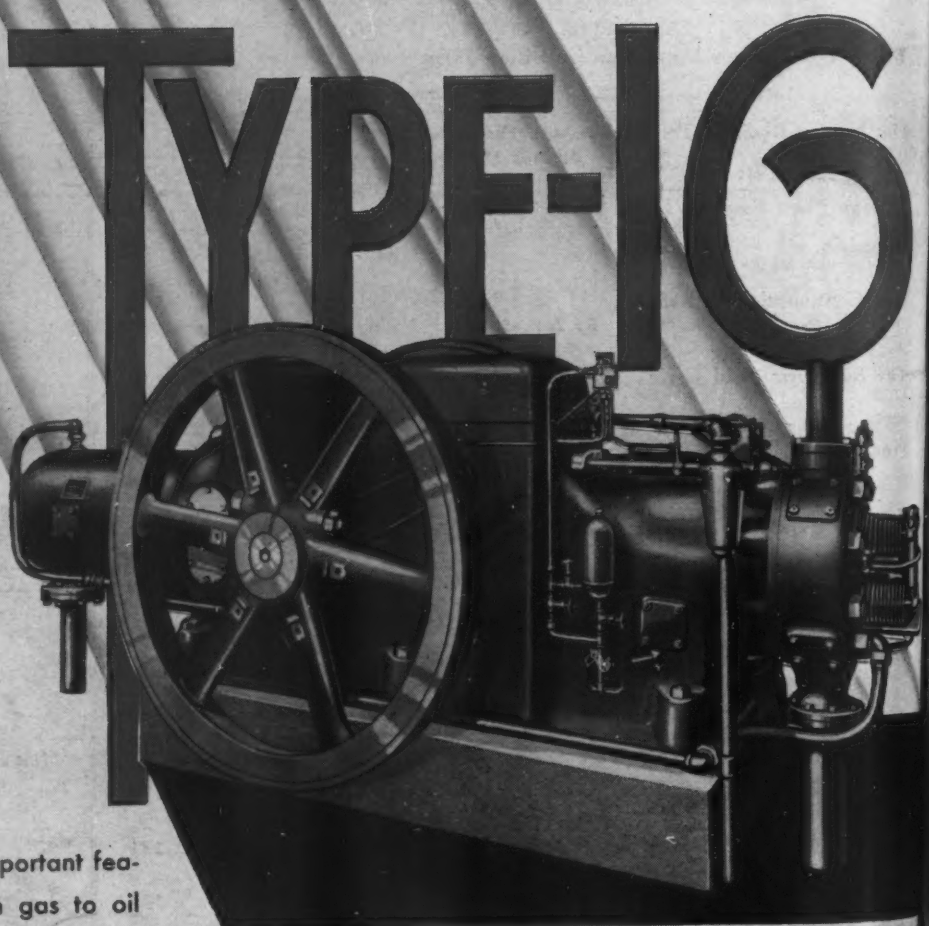

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REFINER
AND NATURAL GASOLINE
MANUFACTURER

A Gulf Publishing Company Publication

VOLUME 9, No. 9 SEPTEMBER, 1930

The Hydrogenation of Mineral Oils

By I. N. BEALL
Chemical Engineer

As has been discussed in a previous article,* hydrogenation offers a new means of increasing the yield and quality of motor fuel. Of major significance also is the fact that hydrogenation presents new possibilities for the manufacture of lubricating oils. Hitherto only nature seems to have been able to produce, under certain conditions, a crude oil having the characteristics essential for lubrication of high powered modern machinery, oils of the so-called paraffin base type predominating in usage for this purpose. It is not thought to be impertinent to the subject of hydrogenation to consider a few theories relative to oil genesis at this point. Nature "speaks a various language" both in her visible and invisible forms.

HYDROGENATION AND CRUDE OIL GENESIS

The major physical factors which influence change within a chemically active system capable of existing in more than one state of equilibrum are time, temperature and pressure. To this there might well be added the quantity factor which is the basis for the law of mass action. Without entering into a detailed discourse it may be mentioned that while each individual factor has its own specific function, the four work together and their duties are to some degree interchangeable. Catalysis enters into the picture as an impetus and guide to reaction. Both selectivity and speed can be improved by the choice of catalysts.

From the thermo-sensitive nature of most virgin crudes, it is not believed that temperatures such as are employed for destructive distillation of carbonacious and hydrocarbon material played an important part in the genesis of crude oil and natural gas. There is geologic or chemical indication that underground temperatures were much different than they are now, except in isolated instances. Nature, however, has not needed to stint on either the time or pressure.

An examination of the crude oils from the geologic strata of different ages reveals some facts that might naturally lead to some broad general conditions. Beginning with the oils produced from the oldest formations the hydrogen to carbon ratio decreases progressively through the paraffin base, napthene base, mixed base to the asphalt base found in the youngest formations. The crudes from the Eastern producing fields of the United States are predominating paraffin base. Those of the Mid-Continent, intermediate, farther to the South and West napthene, and those of Mexico, the Gulf Coast and West Coast are of the asphalt base. Those are the trends. Naturally the deeper formations of the same locality are geologically older than those at the shallower depths the same trend and relationships hold here also to a remarkable degree, as for example the sweet oils from the deep wells of West Texas and Oklahoma. In the Eastern fields deep drilling has been productive only of natural gas, a material in which the hydrogen-carbon ratio is much higher than crude oil. This much also may be stated; that for a given type of crude the higher Baume gravities contain the greatest proportion of hydrogen to carbon. Without going further into detail here concerning the metamorphosis of crude oil (there is an article now

*Refiner and Natural Gasoline Manufacturer, August, 1930, page 77.

THE hydrogenation process consists primarily and essentially in the subjection of a suitable carbonaceous material to the action of hydrogen under pressure, at an elevated temperature and in the presence of a catalyst. The result is the breaking down or disassociation of the molecules of the material under treatment in this manner, and the addition of hydrogen, so that there are formed molecules containing a higher proportion of hydrogen to carbon.

The process is in no way limited to the production of gasoline, and excellent grades of lubricating oils have been made in this country experimentally.

The hydrogenation process originated in Germany in 1914 and originally contemplated the production of oils from coal. It was applied to coal-tar and to petroleum products as well. Over 300,000 barrels of motor fuel were produced by this method in 1928 in Germany and a larger production as attained in 1929.

The I. G. Farbenindustrie, A. G. of Germany, original owner of patents, entered into an agreement with Standard Oil Company of New Jersey for the further development and joint exploitation of the process throughout the world, other than Germany, forming the Standard I. G. Company. This jointly owned company has formed the Hydro Patents Company, controlling the licensing of the process. It was announced July 14 that 17 companies refining in the United States had become stockholders in Hydro Patents Company, and that total operating capacity of these companies represented 80 per cent of the refining capacity of the country.—G. R.

in process of preparation by the writer on this subject) it may be stated that there are strong indications that natural phenomena concerned among other factors, with time, temperature and pressure has been capable of metamorphosing high carbon—low hydrogen material into high hydrogen low carbon material, comparatively speaking.

OXYGEN CRUDES AND SULFUR CRUDES

Oxygen and sulfur are among the usual elemental constituents of crude oils, together with nitrogen in varying proportions. Oxygen and sulphur and nitrogen in free or combined form are also associated with natural gas. The justifiable conclusions are that these elements played an important role in the genesis of both oil and gas. How important a part they could have performed will be subsequently discussed, particularly as concerns oxygen and sulfur.

All of this may seem far afield from hydrogenation, yet in reality it is the heart of the subject. No other two elements can compare with the chemical activity of oxygen and sulfur, insofar as hydrocarbon materials are concerned. Nitrogen too has played its part in the natural synthesis and transformations of organic substances into oil and gas, but its role is not as prominent nor does it fall in the same category. Oils, it seems, should be classified as to either oxygen or sulfur origin. Oxygen has a strong chemical affinity for both carbon and hydrogen, so has sulfur but the affinity is less marked, a comparison for illustration here being drawn between the relative stabilities of hydrogen oxide, (H_2O) and hydrogen sulfide (H_2S) carbon dioxide, (CO_2,) and carbon disulfide, (CS_2).

As another example in the chain of evidence relative to the importance of oxygen and sulfur, it is desired to point out that the high sulfur oils are relatively thermally unstable, and that H_2S is found associated with oils as produced from them on cracking. The examples in the literature are too numerous to quote on this particular point, every refiner of West Texas sulfur crude is familiar with it. It is merely mentioned in passing. Sulfur takes first the hydrogen from a hydrocarbon allowing it to polymerize into tarry asphaltic material: witness the generation of H_2S and the nature of the residue when paraffin wax and sulfur are distilled together. It is true that further action of time temperature and pressure may cause the sulfur to reunite into stronger combination in the form of thiophenes, mercaptans, etc., yet its primary attraction is for the hydrogen. The shallow formation of West Texas where the pressure, temperature and time are less than elsewhere produces H_2S and oil from which H_2S separates easily on pyrogenesis such as cracking under pressure. Under other conditions of time, temperature, and pressure sulfur has been replaced from H_2S and hydrocarbon by the action of oxygen and free sulfur has formed, of which there is evidence in the form of sulfur beds and free sulfur in oil.

In a pressure system where sulfur oil is undergoing pyrogenesis in the presence of excess hydrogen above that demanded for equilibrium, the tendency would be toward desulfuration by the production of hydrogen sulfide. This naturally would take preference over the strictly hydrocarbon splitting reaction, the temperature requirements would be much less. This would be particularly true of those related, thermostable crudes from the Permian Basin of West Texas. The higher hydrogen pressures initiate such reactions at lower temperatures. Oxygen also has a similar action. Both subjects will be treated more fully in subsequent articles on hydrogenation as in cracking desulferization should be accomplished before pyrogenesis takes place as there is otherwise danger of driving the sulfur into stable chemical combinations of the heterocyclic ring series with hydrocarbon such as the thiophene.

Crude oils containing oxygen in combined form

have a somewhat similar reaction with hydrogen under pressure as have sulfur crudes, although the greater tendency is in the direction of hydroxy carbon compounds, such as alcohols, ketones and purporone derivitives. At temperatures of 785° F. and pressures above 1200 pounds, with excess hydrogen the tendency of an oxygenated hydrocarbon system is towards the formation of the aromatic, hydroaromatic and other ring compounds of carbon and hydrogen. In all such systems it must be borne in mind that reversible reactions are taking place and that these can be made to proceed in either direction by suitable variations in conditions of temperature, volume, pressure, or relative quantities of reacting material. With such a system there is great flexibility as the hydrogen or oxygen need not be dependent upon that contained in combination as crude stock.

PRESSURE AND CATALYSIS

Pressure is analogous to catalysis but not so selective in action. Active catalytic surfaces, such as iron, nickel, cabalt, mangenese, carbon, etc. and their oxides have the property of retaining hydrogen, carbon and to a less degree, hydrocarbon. In this way normally gaseous material has great density or accumulation on the surfaces of small catalytic particles. They are absorbed if only momentarily. Such density as exists in these surfaces could only be obtained by the use of high pressures. There exists the difference that molecules attached are attracted to a catalytic surface are diffinitely oriented according to structure, therefore by proper selection of catalysis where it is the desire to manufacture pure or definite compounds, the direction of a reaction can be changed in many instances. Pressure also increases density and creates proximity in a reacting system, therefore in a system such as an oil undergoing destructive hydrogenesis, the nature of the final products can be made to conform to certain predetermined requisites by variation of pressure. In some cases this may be lubricating oil, motor fuel or a synthetic crude. For a high yield and quality of motor fuel from a low grade crude residuum a 20 per cent excess of hydrogen over that theoretically required for the reaction, 3000 to 4000 pounds pressure and 850-950° F. might prove desirable. Hydrogenation at progressively higher temperatures from 300° F. up, before the final zone of reaction would give the presynthesis necessary in all probability. Because of the high specific heat of hydrogen, preheated hydrogen can be used to furnish part of the heat requirements necessary for hydrogenesis and thus cut down

HYDROGENATION applied to petroleum will probably solve the problem of meeting the growing demand for more gasoline from the barrel of crude without at the same time producing excessive quantities of heavier oils, such as fuel oil, which must be marketed unprofitably. In order to produce sufficient gasoline, over production of heavier oils has been burdensome to the industry.

With this process it is possible to obtain a barrel of gasoline from each barrel of crude entering the refinery. Such high yields, however, are not desirable and are not economically advantageous. Industrial Bulletin, Arthur D. Little, Inc. states, "Hydrogenation can be applied directly to crude petroleum, but it is more likely that as much gasoline as possible will still be obtained by straight-running or simple distillation of crude oil. The high boiling oils remaining may then be subjected to cracking, which results in the formation of more light oils, yielding additional gasoline, and the residues from the cracking operation then hydrogenated with consequent production of light products from which still more gasoline will be secured." Such practice will safeguard large investments in skimming and cracking facilities now in use and to be installed later. It is estimated that the net result should be an increase in the yield of gasoline per barrel of crude from the present average of 42 per cent to around 80 to 85 per cent.—G. R.

WITH the perfection of the hydrogenation process the coal and shale deposits of the world have been converted into practically unlimited reserves.

Through the exploitation of this process countries not blessed with petroleum deposits may secure their gasoline and lubricant requirements from the coal mines which abound in practically every important country. Others may rely upon their shale beds, others, perhaps on asphalt beds.

Many countries now dependent upon importation of crude petroleum or heavy distillates for cracking now have this process available when that time comes that depletion of world petroleum deposits reach the point where supplies are not available. Further, in time of war, no country need be seriously affected through lack of petroleum, if coal or shale is abundant.

Hydrogenation in this country will no doubt be applied almost entirely to petroleum products. It is probable that not much immediate use of the process will be made by the licensees, who practically all now are operating costly and efficient cracking facilities. In parts of the world, however, where petroleum is not readily available, coal and coal tar will no doubt be hydrogenated, just as is now the practice in Germany. Hydrogenation of the heavier residues of shale oil plant operation may well follow.—G. R.

THE initial plant for hydrogenation of petroleum residues erected by Standard Oil Company of New Jersey at its Bayway plant, with a charging capacity of 5000 barrels per day, is now in operation. Photographs of this installation were published in this magazine in the issue of August, 1930, pages 78-79-80.

A second unit of similar capacity is under construction at Baton Rouge, Louisiana, for the Standard Oil Company of Louisiana. A third unit is being designed for Humble Oil & Refining Company, which is to be erected at its large refinery at Baytown, Texas.

Operation of these units will be of value to those companies interested in the process for it will enable them to secure accurate information as to the costs of operation of hydrogenation plants on a commercial scale.

Until this experience is gained it is impossible to estimate accurately the economic significance of the new process. It is not thought that cost figures available at present, which are based on the hydrogenation of coal tars and the like, are applicable with any marked degree of accuracy to the hydrogenation of petroleum residues as practiced at the one operating installation in this country. The process will be steadily improved and better economies effected.

It appears that hydrogenation will have its primary application in this country as an additional means of increasing gasoline yields and at the expense of other less needed heavier petroleum products.—G. R.

possibilities of apparatus carbonization. For greatest effectiveness similarly to physical absorption of gas in oil intimacy of contact between oil and gas is necessary. Jets, sprays, screens, etc. are mentioned for this purpose. In strictly vapor phase reactions this is not a problem as under such conditions there is absolute intimacy of contact.

DEHYDROGENATION

Cracking is essentially a dehydrogenation process, not only in that hydrogen is one of the constituents of cracking still gases, but also in the fact that gases rich in combined hydrogen are evolved. Methane is the major constituent of cracking still gases, ethane, propane, etc., occurring in relatively smaller proportions similiarly to wet natural gas. In addition these gases contain, the olefins such as ethylene C_2H_4, carbon dioxide, CO_2, carbon monoxide CO, hydrogen sulfide if sulfur is present in the charging stock, free oxygen and when present in the system, nitrogen. High temperature and low pressure (vapor-phase) give gases of high olefin content the per cent going as high as 52 by volume. The so-called liquid phase high pressure processes seldom yield a gas of over 10 per cent olefin content. Intermediate pressures yield gases of olefin content somewhere in between. Here high pressures refer to pressures between 600 and 1200 pounds intermediate from 80 to 600 pounds and low pressure from atmospheric to 80 pounds. With increasing pressure there is decreasing free hydrogen content of the fixed gases, a decreasing percentage of olefins and an increase in the percentage of saturates. There is likewise a total over all decrease in the amount of fixed gases formed. Pressure at least has prevented dehydrogenation of the normally liquid portions generated. Free oxygen, carbon monoxide and carbon dioxide have been generally noted among the products of oil cracking, which is indication that most crudes contain oxygen in chemical combination, its relative significance in hydrocarbon pyrogenesis is worthy of fuller consideration than space will permit at this time.

MASS ACTION

If a hydrocarbon mixture such as kerosene, gas oil etc., is heated at a constant temperature within the cracking range, it will be noted that at first the degree of decomposition into lighter products such as gasoline and fixed gas will be rather rapid at first. After a period, the percentage of gasoline will reach a maximum then decline but the amount of fixed gases will continue to increase. On further continuance of heating, the system reaches a point where no further chance is apparent, this is equilibrium for a particular set of conditions of time, temperature, or pressure. This makes a good starting point for illustration. Suppose such a state of equilibrium has been reached, the time required was 20 minutes, constant temperature 850° F. absolute pressure 1000 pounds. Holding the temperature constant, the pressure is increased by mechanical means without addition of new material to the system. After another period of time has elapsed a new set of equilibrium conditions will be reached and the effect will be a greater amount of gasoline and heavier liquid over that of the previous set of conditions. If the pressure is held constant and the temperature raised a new condition of equilibrium will be established wherein lighter products will form at the expense of the heavier hydrocarbons. If the pressure is held constant and the temperature is increased the pyrogenesis will be in the following direction: unsaturates→ napthene → aromatic → hydrogen + carbon. It is obvious that every condition involves the time factor and this too would determine the nature and quantities of products formed. It is also apparent that there must be much overlapping between stages except the final stage of hydrogen and carbon. For a given cracking stock the possibilities of time, temperature and pressure could be fully exploited. Now

let it be supposed that the optimum conditions from the standpoint of yield and quality have been attained, there is yet another possibility and it is upon this broad general principle of chemistry that hydrogenation has its basis, that is, mass action.

This law broadly stated is to the effect that at a constant temperature, the products of the active materials on one side of the chemical equation when divided by the product of the active masses of the chemical equation is a constant regardless of the amounts of each substance present at the beginning of the reaction. For substances conforming to the nature of hydrocarbon material constant pressure as well as temperature is essential to the constant. Time, as has already been stated, is required for equilibrium. Every refiner is acquainted with the time factor. For further discussion it is necessary to form the two sides of the equation, this will be done arbitrarily. As hydrogenation is the matter under consideration this will be taken as H_2 + fixed gases + gasoline $\rightleftarrows$ hydrocarbons heavier than gasoline + carbon. Granting the validity of such arbitrary assumption, the addition of hydrogen would among other changes decrease the amount of fixed gas and decrease the amount of carbon. For every variation in temperature or pressure at equilibrium the constant has a new value and the entire nature of the system changes. Hydrogen could be added until the system was no longer chemically active, the conditions relative to mass action and equilibrium would be satisfied. In the final analysis it is the ratio of hydrogen to carbon; combinations of time, temperature and pressure can produce an almost infinite number of variations. At high temperature and low pressure fixed gases and carbon would predominate at lower temperature gasoline, and at yet lower temperature lubricating oil or intermediate oils.

HYDROGEN REQUIREMENTS:

The amount of hydrogen required for the hydrogenesis of an oil can be determined experimentally by methods similar to those used for judging a cracking stock. A combustion analysis for the quantitative amounts of carbon, hydrogen, sulfur, nitrogen and oxygen is also essential, as the nature of equilibrium constituency is determined on an elemental basis. Inasmuch as there is usually a near sufficiency of hydrogen to carbon for motor fuel requirements in the original oil, it is only necessary to provide for a large initial supply of hydrogen. The excess hydrogen over that contained in the oil is necessary rather for the maintenance of equilibrium than for the actual requirements as to product. Once an initial supply of hydrogen has been provided, the further requirements are small as it is only necessary to recirculate the equilibrium gases from a former cycle and add only an additional quantity to make up for that used or lost. The great consumption of hydrogen in cracking processes has been due to that lost as the free gas and hydrocarbons lighter than motor fuel. Even asphalt has a greater ratio of hydrogen to carbon than the benzol hydrocarbons falling within the distillation range of commercial motor fuel. On an oxygen, sulfur, nitrogen free base Trinidad asphalt shows 11.3 per cent hydrogen by analysis whereas benzole is 7.8 per cent ordinary straight run gasoline

(*Continued on page* 126)

HYDRO Engineering and Chemical Company has been formed as a subsidiary of Standard Oil Company of New Jersey, and has established its offices on the second floor of the Durant Engineering building, Elizabeth, New Jersey

E. M. Clark is president of the new company. R. T. Haslam is operating vice president, and R. P. Russell is general manager.

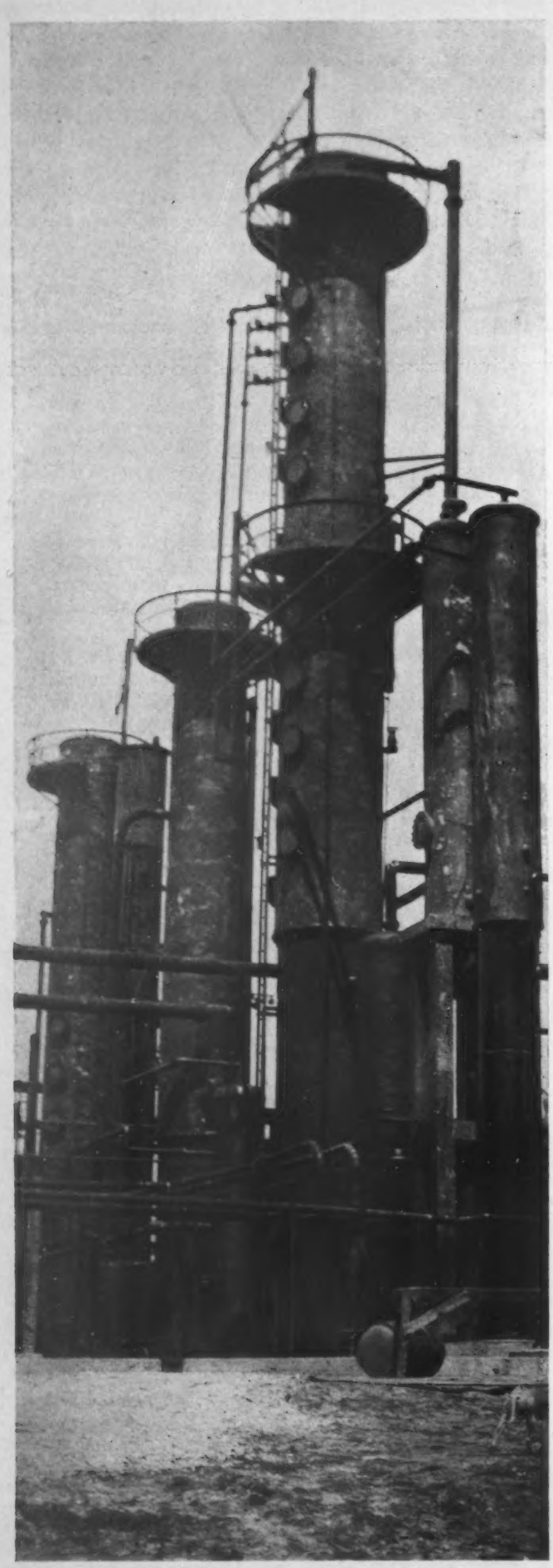
The new company has charge of the engineering, design and initial operation of plants erected for the hydrogenation of petroleum. It will also render technical service to operating plants and one of its principle activities will be that of manufacturing the necessary catalysts required by the process.

R. P. Russell, general manager, was formerly of the staff of the Massachusetts Institute of Technology, later directed research for the Development and Research Department of the Standard Oil Company of Louisiana at Baton Rouge, where the original hydrogenation work in this country was performed over a period of two years. From this position he was promoted to general manager of Hydro Engineering and Chemical Company.

Willard C. Asbury has been placed in charge of the chemical engineering department for the new company. He was formerly with Standard Oil Company of Louisiana, research department. Charles F. Hesselbach has been placed in charge of mechanical engineering for Hydro Engineering and Chemical Company coming from the general engineering department of Standard Oil Development Company. Edward J. Gohr has been transferred to the new company from the Humble Oil & Refining Company, Baytown, Texas plant.

At Baton Rouge, Louisiana, R. P. Russell is succeeded by Marion W. Boyer, recently appointed director of research. William V. Hanks and Garland H. B. Davis have been appointed assistant directors of the Baton Rouge laboratories.

J. J. Small has been transferred from the Louisiana company to the patent department of Standard Oil Development Company, New York, New York.



Wilcox Has Installation Plant

WILCOX OIL & GAS COMPANY has been operating its new refinery at Bristow, Okla., a little more than a year, during which time certain additions and changes have been made to secure products not originally required and to generally improve efficiency. The refinery is on the same site as the original 1000-barrel Wilcox experimental plant erected 10 years ago, which was operated under lease by Riley Petroleum Company until 1928, and which was completely dismantled to permit erection of the new 4000-barrel modern skimming-cracking plant. Decision to erect and operate a refinery follows entry of the company into wholesale and retail marketing and subsequent expansion of these facilities in territory within a radius of 300 miles of the refinery. Like most modern installations of the type this plant consists of skimming plant, cracking unit, and redistillation battery, with vapor recovery system and continuous treating equipment.

The greater portion of the 4000-barrel crude requirements of the refinery is produced locally by the company, and as soon as it is practical the crude is brought direct to the plant from the field, thus eliminating expensive storage and handling facilities. However, this practice is conducive to relatively high percentages of b. s. & w. in the crude, which must be settled out before actual processing at high temperature. This is accomplished by means of preheating the fresh crude in a series of Cloverleaf coils

Fractionating equipment in connection with crude topping unit and pressure distillate re-run stills.

Modern in Bristow

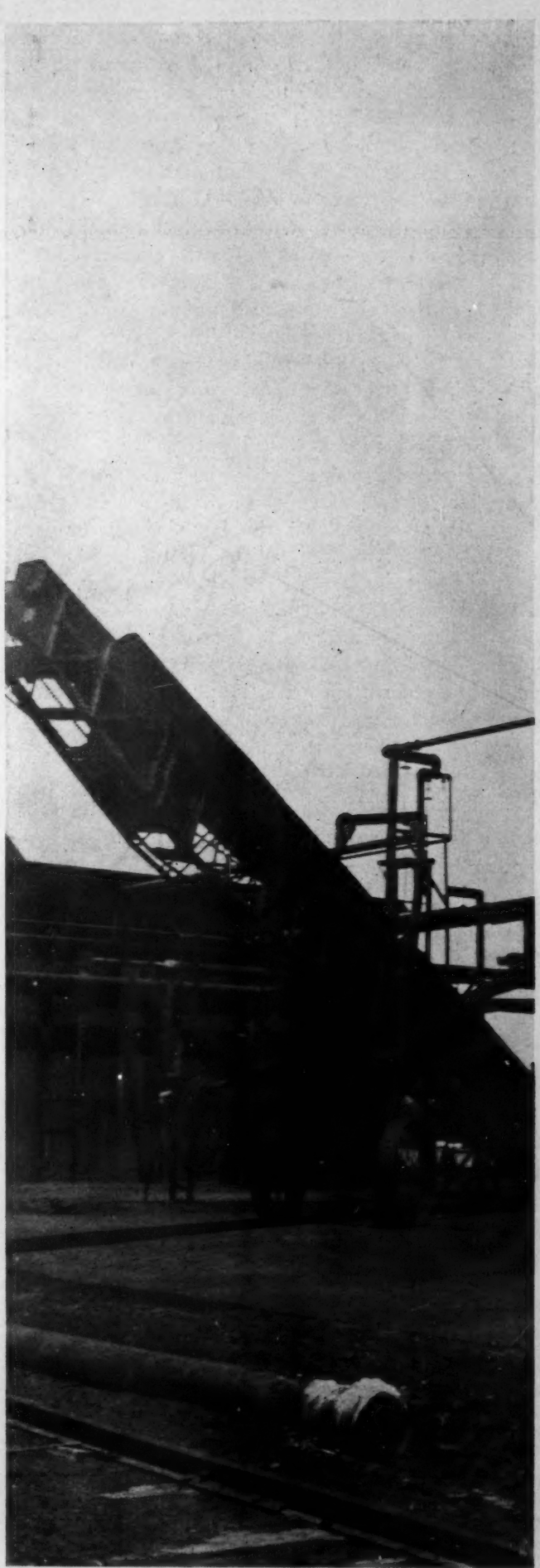
By GEORGE REID
Associate Editor

placed in the uppermost section of the skimming unit fractionating column where the oil is preheated to about 200° F.

From this point the crude passes into one end of an eight by 24 foot horizontal settling drum (formerly having seen years of service as a shell still) where the settling time is sufficient to let the foreign materials drop out of the oil. Clean crude is drawn continuously from the front and top of the drum, and b. s. & w. is continuously removed from the front and bottom of the settler.

The crude is then further preheated through counter-flow through a series of exchangers, absorbing heat from the residum leaving the base of the separator column. The temperature is raised to about 350° F. before it enters the pipe still. This Winkler-Koch distillation unit consists of 124 tubes 3½ inches I. D. and 22 feet long, arranged in two convection banks and one roof bank. As the oil leaves the roof tubes it has been heated to about 520° F. and at this temperature it enters the bottom of the large fractionating column.

The column was designed by the same engineering concern, and is six feet in diameter by 75 feet high. It contains 17 bubble decks and two blank decks, one of which is approximately half way up the height of the tower from which point a kerosene side stream or gas oil is removed; the other blank deck being just below the top three bubble trays where a side stream of gasoline is removed. Former design called for



By means of this conveyor coke dropping from the reaction chamber is loaded directly into cars for shipment.

removal of a kerosene side stream into a flashing or stripper tower, and withdrawal of residuum through a similar flash tower, flashing both with superheated steam, and returning flashed vapors to the original column. Under the present practice the upper auxiliary tower or side stream produces a stream of 437 e. p. naphtha, and a 375 e. p. gasoline stream is taken off over head. Gas oil may be removed from the lower withdrawal equipment, and fuel oil is taken from the bottom. Condensed 375 e. p. gasoline is taken from a large water separator device and returned over the top of the column as a means of temperature control. This control is also aided by passing the incoming crude through the coils in the top of the tower. Residue is pumped from the tower by liquid level control into raw oil tanks for the Dubbs unit.

This change in design and in the number and type of products fractionated through the large bubble column is an example of the flexibility of modern rectifying equipment. With slight mechanical changes the operation of the tower may at any time be converted back to the original system or to meet some other requirements. The two grades of gasoline produced in this operation are given sodium plumbite treatment in a continuous treating system to meet Doctor and corrosion specifications.

CRACKING OPERATION

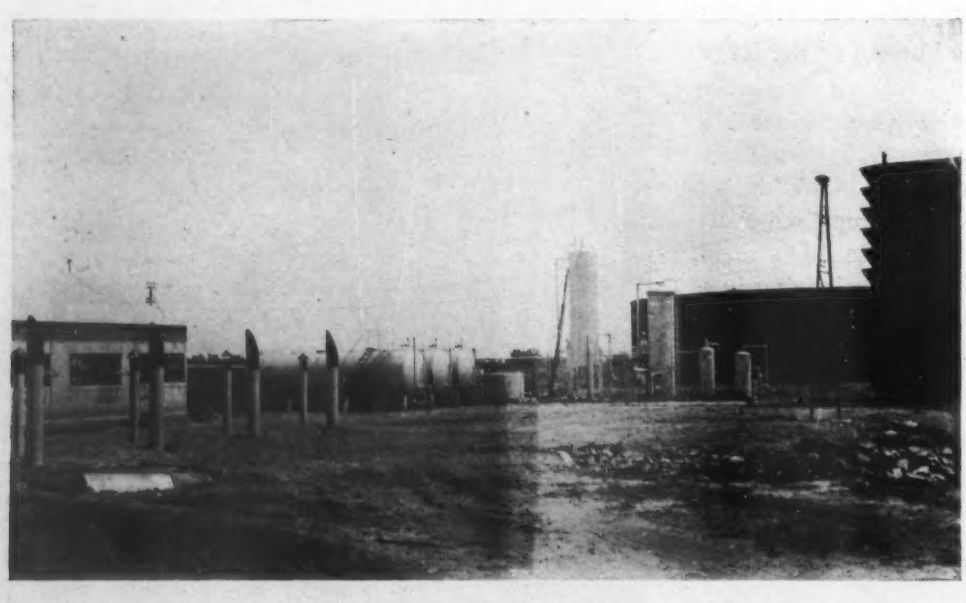
The Dubbs cracking unit is equipped with a 10 by 40 foot reaction chamber and late type modified Alcorn radiant heat furnace. Several changes in design were effected in this furnace and its operation. Special alloy beams have been installed to support the radiant shield getting the weight off of the tubes, the arch was removed, the number of tubes was reduced to 64 and the flow of oil was reversed. These changes and other details were worked out by Dubbs Alcorn and Wilcox engineers, due to the new design of the furnace. The unit is operated in three days cycle running non-residuum. At present the production of topped crude is in excess of the capacity of the single Dubbs unit, and the company is considering the installation of additional cracking equipment.

Through the use of equipment designed for direct loading of coke into cars the coke production is handled but once at this plant. A spur track was built close to the reaction chamber from the nearby railroad. A conveyor with a hopper large enough to fit under the reaction chamber, is employed to dump the coke directly into the cars. As the 4300-foot cable is pulled from the chamber by means of a steam hoist, the electrically operated conveyor removes the falling coke, free of nuts, bolts, dirt and other foreign matter, spilling it into the cars. It is estimated that this conveyor has reduced the cost of handling coke about one dollar per ton, and as seven to eight hundred tons are handled monthly and sold on contract to a large industrial concern, there is real economy effected in this method of handling the product.

Pressure distillate from the cracking operation is taken to the treating department and treated with four pounds of 66° Be. acid per barrel and neutralized with 17° Be. caustic in a continuous system. The distillate is then taken to rerun stills. This system consists of two 12 by 30 foot shell stills equipped with bubble towers. Incoming 50 gravity pressure distillate is charged through Cloverleaf sections placed in the tops of the two bubble towers. After this preheating it enters the shell stills. Through the addition of a new stripper tower in connection with the second bubble tower, the rerun system is producing a fraction of stripped furnace oil of about 34 gravity. The bottoms are marketed as 28/30 gravity fuel oil. Overhead stream from the fractionating equipment is a premium grade 400 end point anti-knock motor fuel and marketed as such. A side stream of 425 end point gasoline is removed which is blended with the straight run gasoline.

Cracked gasoline from the rerun operation is given Doctor treatment in a continuous system. The straight run gasolines are given similar treatment. Two complete continuous

(Continued on page 122)



Compression gasoline recovery plant and gas washing equipment

Rio Grande Los Angeles Plant

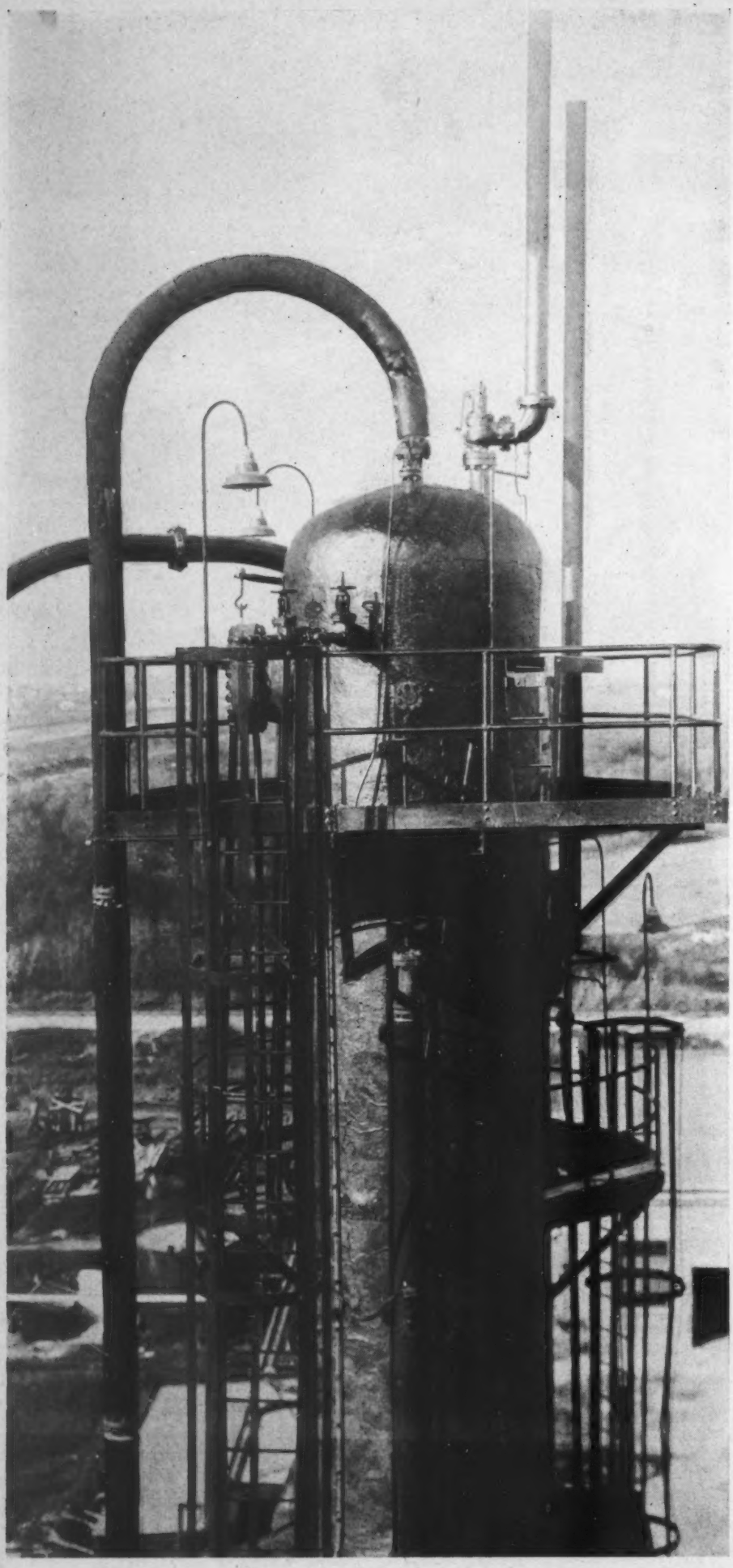
Hot Vapors Redistill Treated Pressure Distillates

By BRAD MILLS
Staff Representative

IN August, 1929, Rio Grande Oil Company completed and placed in operation two high pressure cracking units at its Vinvale refinery, near Los Angeles, to be operated in conjunction with older straight-run units; and the success of the installation has been so outstanding that records established during the period prove the wisdom of following up straight-run methods with a suitable cracking process. Regarded as one of the most modern cracking units yet built and incorporating many interesting features, the plant has overcome several operating problems which handicapped earlier attempts at cracking heavier California fractions. The methods employed in treating gasoline and recycling oil were perfected only after a long series of experiments, each adding to the efficiency and lower cost of operation of the plant. Local conditions and nature of the product run necessitated the inauguration of practices which probably will be adopted as standard in the future.

Development of a re-run process which permits the cracking units to make a finished motor fuel is an interesting achievement, and it was largely at this plant that the practice was perfected. By utilizing waste heat through the installation of heat exchangers and continuous acid treaters, the necessity of re-running the pressure distillate or synthetic gasoline in outside equipment is eliminated. Early practice was to use condenser boxes and rundown tanks, agitators and stills to obtain a finished gasoline. This was an expensive process and retarded development of cracking processes in California.

The re-running process within the cracking units to make a finished product has reduced the treating cost materially and has completely eliminated the treating losses. The gasoline recovery was formerly from 75



Top of cracking unit fractionating column

to 80 per cent, while the present recovery is actually better than 100 per cent above the Hempel column test. There is no actual gain in the process, the higher final recovery indicating the fallibility of the Hempel column test. The final determination does prove an almost complete recovery, however, and the elimination of treating losses. Formerly the cost of treating varied from one to two and one-half cents per gallon. Company engineers and the manufacturers shared honors in perfection of the re-run and treating process, which was something new to California.

The plant is now operating on Santa Fe Springs, Long Beach and Elwood crudes, the gravity ranging from 28 to 38 degrees. It is located about midway between the two great fields of the Los Angeles basin.

By way of explanation, it might be well to touch lightly upon the older straight-run equipment, its method of operation and its connection with the cracking process. The original plant was built in 1922 and is now handling above 12,000 barrels of crude. The flow chart is similar to that accepted as best at the time of construction. Large reciprocating pumps send the crude to the heat exchangers, which are used to counterflow the fuel oil returning to storage. It is then pumped to the flash chamber where a portion of the gasoline is flashed off. From this point it is taken successively through the five large stills, the vapors being drawn off from each in the conventional manner. The fuel oil goes to storage and the gasoline to rundown tanks and continuous treaters.

Completion a year ago of the two cracking units radically changed the company's refinery operations and made possible the recovery of a greater percentage of gasoline from the original

WM. MURRAY
Refinery Superintendent, Los Angeles plant

J. J. DOWNEY
General Superintendent of Refineries

W. T. CHRISTMAN
Superintendent of Pressure Stills, Los Angeles Plant

crude runs. The two Jenkins units each have a capacity of about 2500 barrels and are operating at about their normal rating.

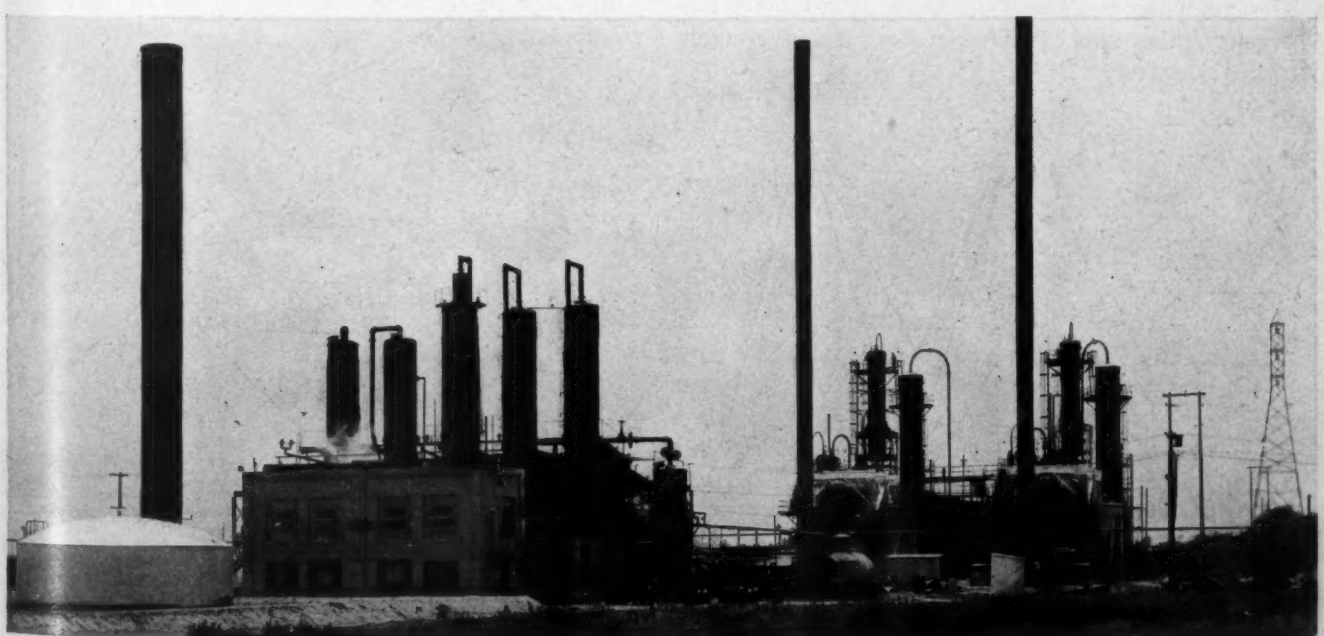
CHARGING STOCK BLENDED

Three 10,000-barrel charging tanks are being used in connection with the cracking units, one being used for fuel oil, into which is pumped the recycle oil. The cracking units are now operating on a mixture of 40 per cent fuel oil and 60 per cent recycle oil, this charging stock remaining constant by pumping the recycle oil into the bottom of the fuel oil tank. The percentage of each required to make the best charging stock was determined after a long series of experiments. The first runs consisted of about 35 per cent of recycle oil and 65 per cent of fuel oil, but constant tests revealed this mixture to be out of balance. The first increase in the quantity of recycle oil indicated a higher percentage was necessary.

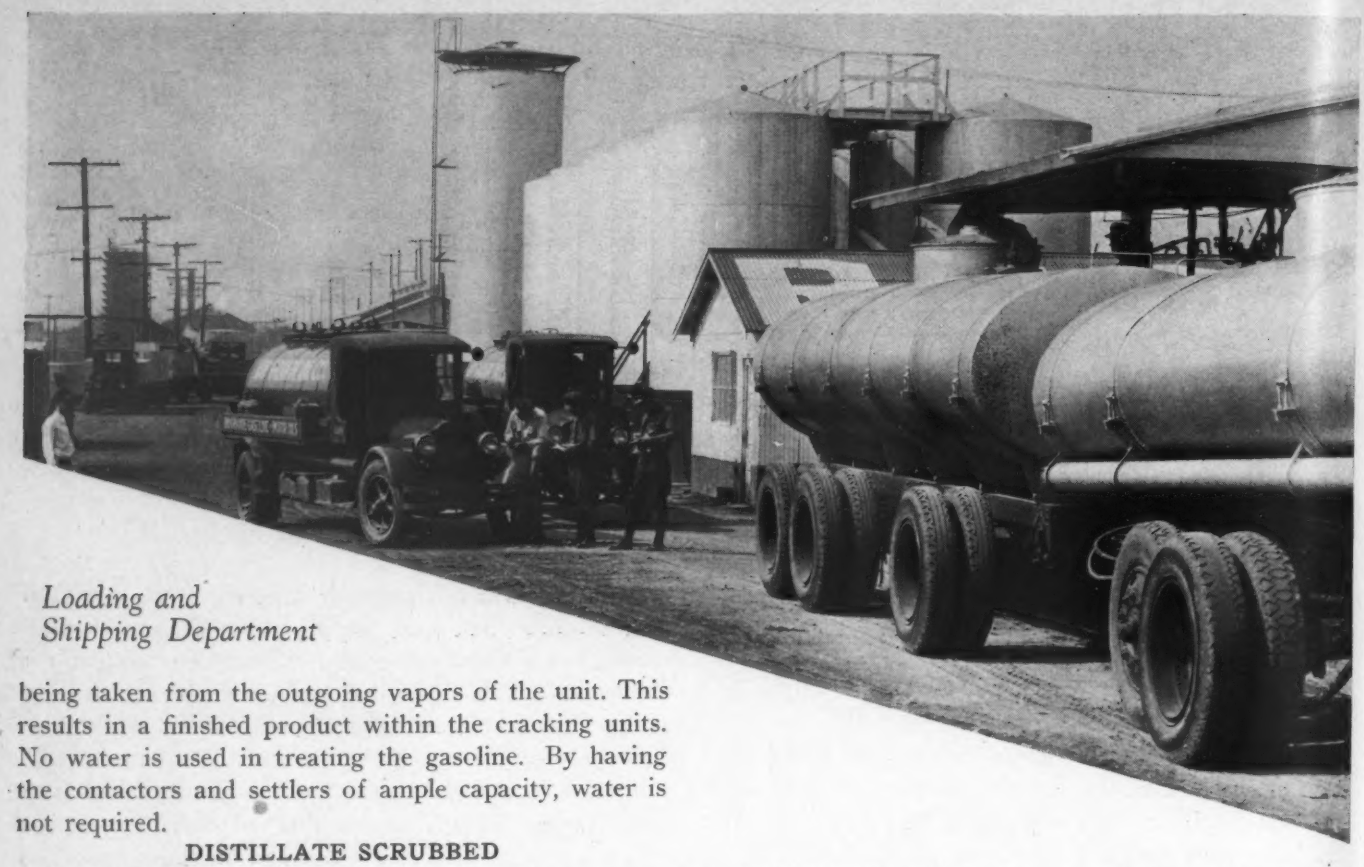
Aside from several devices perfected at the plant and intended to meet local conditions, the flow chart of the cracking units is not radically different from the latest type of these units now being built in California. The charging stock enters the heat exchangers, going to the top of the reflux tower and counter-flowing the vapors as it drops downward in the tower. From the bottom of the reflux tower it is taken to the still, thence through the tubes of the still by mechanical means, a 75-horsepower motor being used for this purpose.

Vapors leave the stills through a goose-neck and enter the bottom of the reflux tower, the temperature being controlled by a trim coil, through which cold oil is circulated to hold the outgoing temperatures of vapors to that desired by the operators. The vapors are then released from a pressure of 200 pounds to about 30 pounds and the oil condensed. This product is the pressure distillate or synthetic gasoline which formerly was treated in outside plants.

The pressure distillate is taken to the treating plant and treated with sulphuric acid and doctor solution and then returned to the Jenkins units and rerun, the heat for vaporizing the gasoline from the pressure distillate



Skimming and cracking departments



Loading and Shipping Department

being taken from the outgoing vapors of the unit. This results in a finished product within the cracking units. No water is used in treating the gasoline. By having the contactors and settlers of ample capacity, water is not required.

DISTILLATE SCRUBBED

Three scrubbers are used in passing the pressure distillate to the rundown tanks. A weak solution of caustic soda is used, removing all hydrogen sulphide and making the product easier to treat, besides reducing the quantity of chemicals used. The addition of these scrubbers has been reflected in subsequent ease of operation during the re-run process.

Corrosion has been eliminated through the use of lime in the charging stock, about .28 pound of lime now being used per barrel. Rapid motion of the charging stock keeps the lime in suspension within the system and gives a uniform mixture with little settling out.

The pumping equipment is ample for almost any emergency, the standby arrangement being roughly equivalent to that in regular use. A three-stage Ingersoll-Rand centrifugal pump is used for the main feed, a large steam driven turbine pump of the same dimensions being used for a standby. Two nine by 5½ by 10 duplex pumps handle the pressure distillate after it has been treated, re-running it through the system, one of these pumps being used for emergency. The recycle oil pumps include two, nine by 5½ by 10 duplexes, one being used as a standby. Two 14 by six by 12 centrifugal trim pumps have been installed, one being electrically driven and the other steam driven, either one being used as a standby. Three 4½ by 1¼ by eight lime pumps are being used, only two of which operate at one time.

Laboratory and plant office

Chicago Plant Employs Latest Scientific Practices

THE East Chicago, Indiana, refinery of Empire Oil & Refining Company completed and placed in operation this summer is of the skimming and cracking type, with gasoline as the major product; kerosene, furnace oil and coke constitute the lesser products.

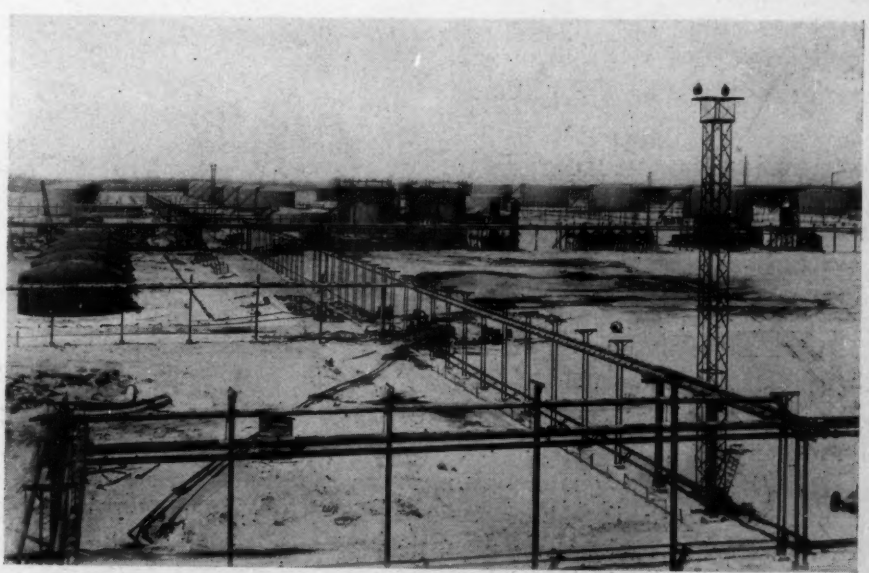
The crude oil distillation facilities consist of two Badger units of the double flash type, having a rated capacity of 9000 barrels each. The plant is operating, however, at a charging rate of 15,000 barrels. Crude from any of six 80,000-barrel oil receiving tanks is charged through a series of exchangers where it is preheated to about 300°F. absorbing heat from residuum and overhead and side streams from the fractionating columns. Tube still temperature is sufficient to heat the crude to about 550°F. at which temperature it enters the first tower.

A light stream of gasoline is removed overhead from this first column and the partially denuded crude then passes into a second fractionation-separator column from which a second gasoline stream is removed overhead and side streams of kerosene and furnace oil, with residuum collecting in the base of the column for removal through exchangers and coolers and cracking unit charging stock storage tanks. This method of operation was outlined in a recent issue of The Empire.

Six Doherty cracking units of latest design are employed for cracking the topped crude from the skimming plant operation. Bottoms from the skimming operation, however, are also available for sale as fuel oil. The line from the topping or skimming plant to the four 55,000-barrel storage tanks is equipped with a flow meter which is located in the fuel oil pump house. This is a separate building centrally located between the pressure still charging stock tanks and the fuel oil tanks. At the pressure still charging stock tanks a uniform blend of recycle gas oil is maintained by continuously pumping this product into the tanks, the amount being controlled by a Foxboro flow controller. This process is so arranged that when the charging stock tank is full it will contain the proper percentages of raw oil and recycle gas oil thoroughly blended in the charging tank.

Charging stock is transferred to a surge tank in the pressure still department and pumps taking suction on this tank charge the cracking units direct. Pressure benzine or pressure distillate and residue is made in this process, as well as the usual small amount of coke. Pressure distillate is handled through the continuous acid treating plant, and then charged to a Badger rerun unit with rated capacity of 12,000 barrels daily. This unit is much like the crude distillation facilities with the exception that but one fractionating column is employed. Gasoline and furnace oil are derived overhead and from the side of this column with the residue from this operation being recycle gas oil, which is blended back into the fuel oil and recycled through the cracking units.

From the receiving house the various overhead products are carried to the 35 2500-barrel run-down tanks through cast iron flow lines—cast iron being used because of its high resistance to corrosion. Gasoline and other products are handled through the light oil pump



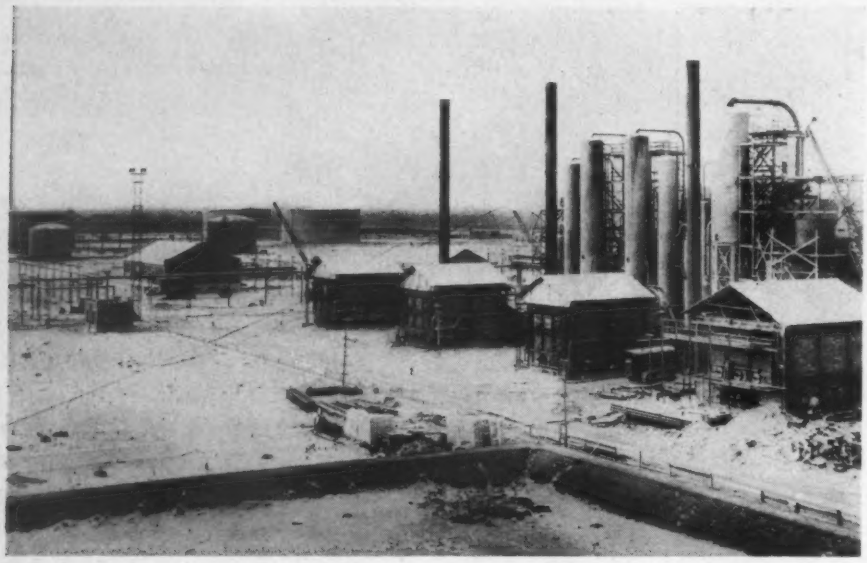
Chemical treating department is shown in the center, with the acid recovery plant at the right of the picture. Light oil pump house and loading tanks are shown in the background. To the left are the pressure distillate re-run unit run-down tanks.

house. This pump house is of late modern design and construction, as is each department of the plant. It is provided with two rows of motor operated centrifugal pumps, and the various manifolds in the two wings. The centrifugal pumps are located below the bottom line of any tank in the refinery, insuring a flooded suction. The pumps and manifolds are so arranged that one-half of the pump house handles the unfinished products from the stills to the agitators and the other half handles the treated oils from the agitators to the storage tanks and ultimately to the loading rack.

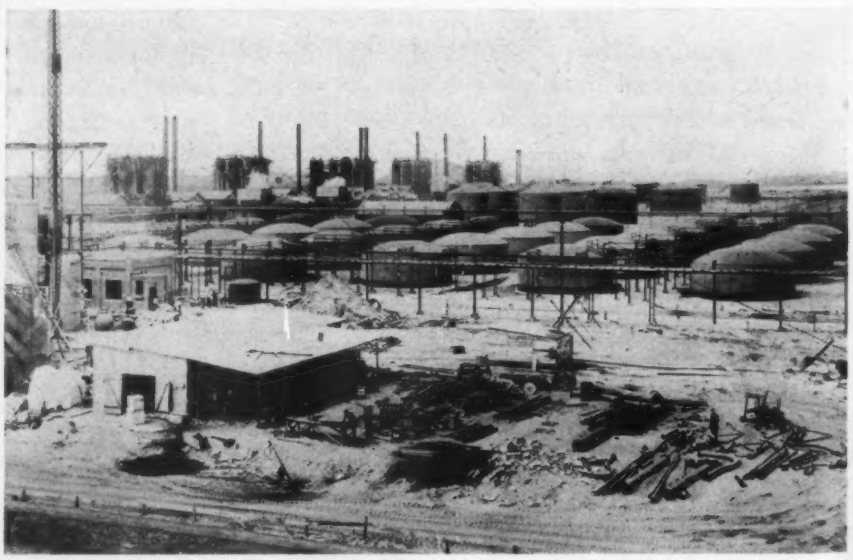
Gasoline, kerosene, and other products are treated in a battery of 3000-barrel batch recirculating type agitators. Serving the agitators is a main treating plant pump house containing three 14-inch recirculating pumps, two centrifugal water pumps, three centrifugal caustic pumps, and a high and low pressure air compressor, all of which equipment is electrically operated by remote control. Liquid caustic for chemical treatment and neutralization work is received at the refinery in liquid form and in tank car shipments, thus eliminating the usual troublesome caustic "melting" equipment found at many refineries. A litharge recovery plant is installed which through the recovery of chemicals effects a saving in treating costs.

The refinery site covers 377 acres and is exactly one mile long. The plant is so laid out as to take every advantage of topography of the location and the equipment is built so that the least amount of transferring of products is necessary. Provisions are made for further expansion both of present facilities, and of new and different types of facilities as well.

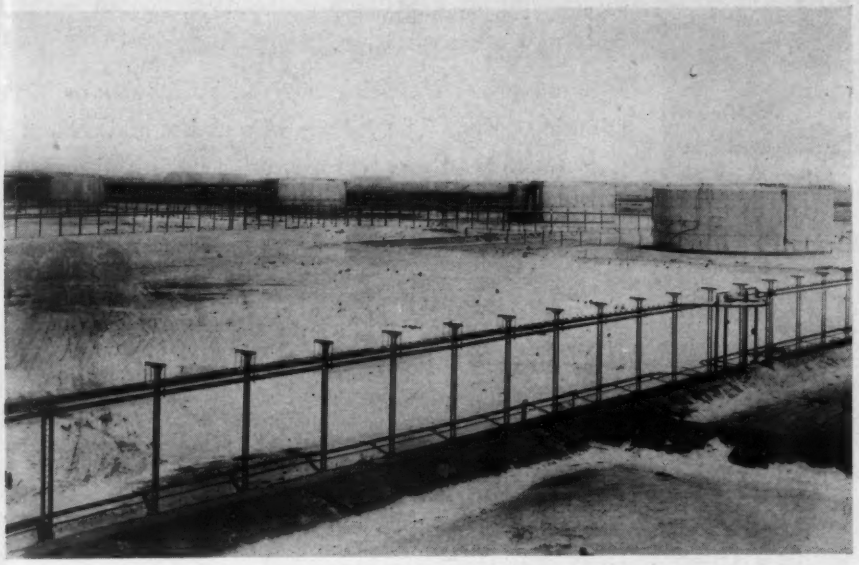
The Chicago plant is a picture of modern refinery equipment, design, and practices. Every piece of equipment and individual detail has been selected with a view to the erection of a refinery embodying the latest scientific principles, and operating with the highest possible efficiency. This installation is the eighth of the Cities Service refineries, others being located at Cushing, Okmulgee and Ponca City in Oklahoma, Gainesville, Texas; East Braintree, Massassachusetts; Pettys Island, New Jersey, and Titusville, Pennsylvania.



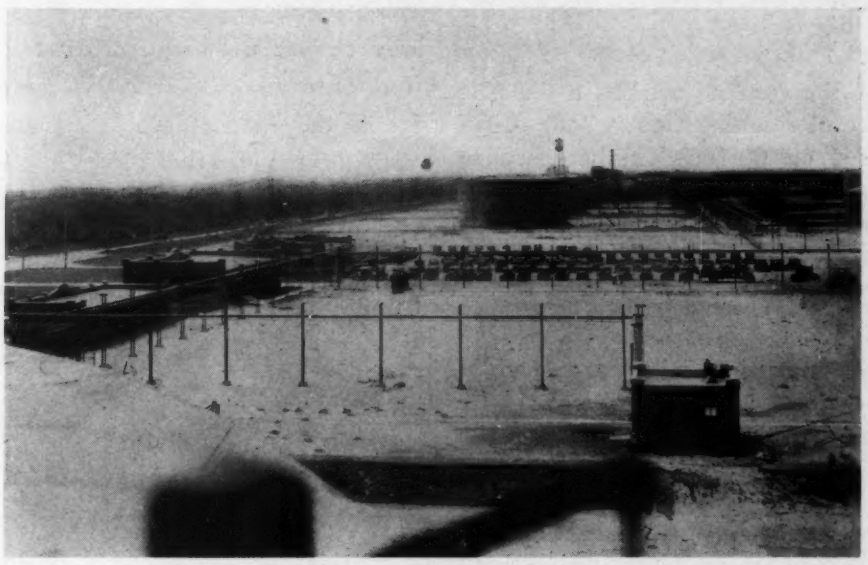
Topping and pressure distillate re-run units are shown at the right. At the left center is the warehouse. In the left background is shown the 55,000 barrel residum storage tanks.



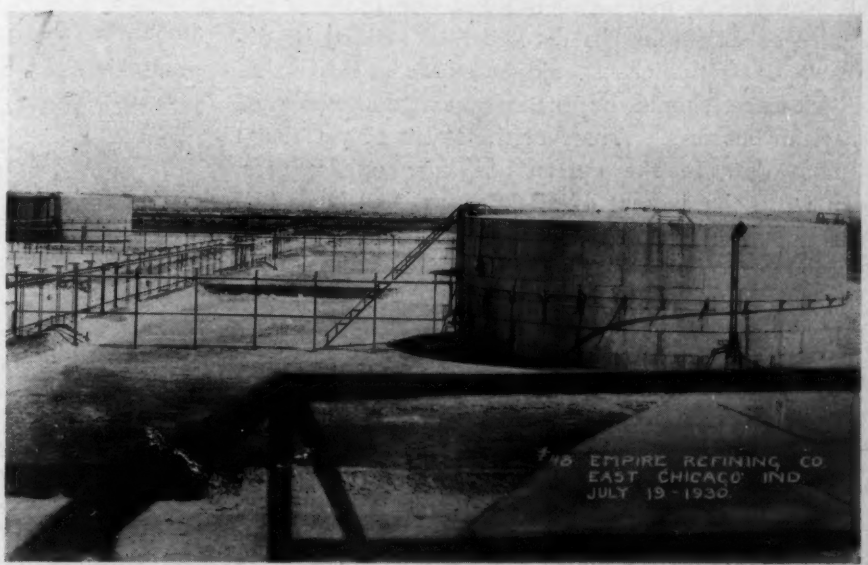
In the background is the cracking department of Empire Oil & Gas Company's East, Chicago, Ind. plant, using Doherty units. Topping and rerun department run-down tanks in the center.



80,000 barrel crude oil storage tanks receiving crude through the Texas-Empire pipe line from Mid-Continent fields.



At the left is the office, change house, and garage at the entrance to the yard of Empire Gas & Fuel Company's East Chicago, Ind. refinery. In the background are the 55,000 barrel fuel oil tanks



The tank farm is levelled, graded, dikes oiled and packed, and weeds kept closely cut. Overhead lines convey steam to each tank, also conduct vapors to the gasoline recovery plant.

REFINER
AND NATURAL GASOLINE
MANUFACTURER

EDITORIALS

THERE is evidently a tendency to weigh the petroleum industry as a unit not related to the whole economic structure. While it may result from the necessity of a set of men paying close attention to the circle of their endeavor, still it has its pitfalls and to some extent may be responsible for the hoisting of distress signals.

It is not possible for one industry to remain prosperous when all others are not prosperous. No industry can free itself of other industries. Neither can the course of an industry be charted without charting the trend of industry as a whole.

The sorry state of the gasoline market in the past summer gave evidence of resulting from a scale of refinery operation based on the opinion that gasoline consumption would show a gain over 1929. The students of gasoline consumption had his figures for several years past. From them he could plot a curve showing the average yearly gain in gasoline consumption.

But gasoline, to have maintained its average climb in 1930, would have had to pull away from the composite curve of all other commodity movements. When the registration of new automobiles for the first half of 1930 showed a drop of 32 per cent in Oklahoma, it had a depressing effect on gasoline consumption. The automobile is but one of several hundred items whose trend pulled downward on the gasoline curve.

It is time for the petroleum industry to cease the practice of diagnosing its ills and then making its decisions. Its conditions should be studied. After that the telescope should be turned upon the whole of American business. Whatever the status of petroleum it must flow in the current of common business. Even when the current of all business is unfavorable, petroleum will fare better in the common course than it would if steered against the current.

STEADILY the maker of gasoline becomes the retail seller of the product. As the wave of integration swells it is well for the refiner to remember that the tendency of retail selling costs is downward.

While gasoline may not equal the status of some other commodities for which the consumer pays three times the manufacturing cost, still the cost of a gallon of gasoline at a refinery is small compared with the price at a service station.

Retail prices are being lowered by reductions in distribution costs. The refiner who makes and sells at retail must bend his efforts at reducing distribution charges.

MERGERS still come to a close while others reach the rumor mill. They bring their wrinkles to the brow as well as head shaking, which implies that men can not fathom the mystery of the merger.

There is no mystery about mergers. On the contrary they are inevitable.

For several years the petroleum industry has been adding assets in both raw and finished products. These have become a burden. Now the assets are passing from concerns whose finances can not uphold the burden to the concerns whose finances are sufficient to carry the products until sales will be profitable.

Numerous oil concerns with satisfactory cash amounts and exceptional physical assets will be drawn into mergers. While the cash total looks huge it still is not sufficient to pay the costs of carrying the excessive materials until the day of profit arrives.

A RULING by the Attorney General's Department that gasoline extracted from natural gas in Texas is subject to gross production tax of two per cent has led to efforts on the part of the state to collect $2,500,000 back taxes. This source of income will amount to approximately $350,000 annually. The gross production tax on oil was first imposed in 1907, the rate then being one-half of one per cent. In 1919 the rate was increased to one and one-half per cent. In 1923 the present law was enacted. There has been a great increase in the production of natural gasoline since 1916, the earliest date for which statistics were examined to discern the amount of taxes due the state. No suggested steps in the recovery of this delinquent tax has been mentioned but it is presumed that the task will fall to the attorney general and the state comptroller. Value of the gasoline for determining the tax will most likely be taken as the average market value during the quarter preceding the date of payment as and when produced.

Fuel Consumption in Refineries

By JOHN S. BLAIR
Mechanical Engineer, Producers & Refiners Corporation

THE subject of efficient use of fuel is now receiving considerable attention from the refiners of the United States.

That this consideration has not been given long ago is due to the comparative cheapness of most refinery fuels as well as to the fact that the industry has been confining most of its efforts to a reduction of operating losses in the various processes in use.

Neither was the competition in the sale of manufactured products so pronounced as has prevailed for the past few years, but the refiner's operating margin has and is steadily decreasing.

Today, the refiner who is not taking advantage of the more recent methods of operating practice with efficient equipment under laboratory control, and who is neglecting any opportunity to reduce his losses is doing business under a serious handicap.

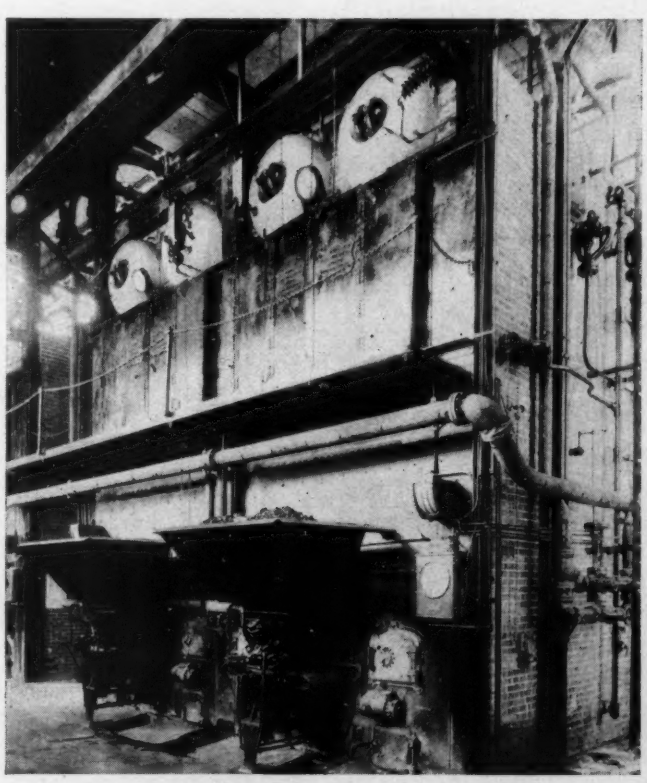
In the Mid-Continent, natural gas, stripped gases from topping stills and cracked gases from pressure processes, fuel oil, petroleum coke, acid sludge and pressure still residuum constitute the more important fuels, although coal, bagasse and slabwood are fuels in some sections.

The ordinary shell still as usually set, is a notorious waster of fuel. The furnaces are too long for their width and height, resulting in extremely high gas velocities and incomplete combustion. A fuel consumption representing from three to six per cent of the throughput is common on this still. At 15 cents per 1,000,000 B.t.u., a reduction from six per cent to three per cent of fuel per barrel of Mid-Continent crude topped in a shell still represents a saving of from 12 to 15 mills per barrel charged. Ordinary boiler practice of workable dampers and tight settings will effect such savings even with a high excess of air, provided the air is supplied at the proper places.

Modern pipe stills for topping crude and re-running pressure distillate will show a fuel consumption of less than 1½ per cent of the charge. This is due entirely to the fact that provision is made for plenty of furnace volume for complete combustion of the fuel, proper air application and utilizing a portion of the radiant heat.

Pressure still operation at high temperatures gives further opportunity for economy through the use of recirculated furnace gases, preheated combustion air, and economizers.

The large quantities of steam required in refining operations necessitates burning a great amount of fuel, but because in many instances the cost of the steam used in different departments is merely an arbitrary figure set up from more or less assumed data, or neglected altogether, there has been little incentive for generating steam economically.



Canfield Oil Company's power house, Corapolis plant

OLD TYPE BOILER SETTING

Except in the larger plants, boiler room equipment generally is of an antique if not obsolete nature. That nearly half the plant fuel is consumed in the boiler house should stimulate efforts to burn this fuel as advantageously as possible.

No end of return tubular boilers are being set according to the old approved Hartford setting without regard for the type of fuel to be burned, and in nearly all cases set too low. Water tube boilers are better in this respect since their design-

ers have come in contact with the demand for higher settings.

Here, as with the stills, there are leaky settings admitting large quantities of air at wrong places and in most instances providing a great amount of excess air. The fact that an efficient furnace consumes all the fuel with a minimum of excess air is apparently ignored.

As a usual thing, instruments are rare in a refinery boiler house. There is no way of knowing how much fuel is being burned, how much water is being fed, how much steam is being produced, the temperature of the flue gases is not considered, no indication of draft conditions is present and even the temperature of the feed-water is unknown in many cases.

These things are vital. After a setting is made tight there should be some means of determining the chemical nature of the flue gases. Then the dampers can be set to maintain a good condition, but a damper is essential for regulating the damper opening according to the indications of the flue gas analysis. No cost figures can be determined unless means are provided for measuring the water, fuel and steam.

When it becomes apparent that an increase of 10 degrees in the temperature of the feed water will effect approximately a one per cent saving in fuel, the need for feed water temperature is obvious.

Superheaters are fuel savers besides providing higher temperature steam for process work, reducing condensation losses and maintenance due to injury to machinery from accumulated condensation in the mains.

Fuel losses are more easily checked and remedied than evaporation losses. Under present day conditions in the industry, the refiner is compelled to cut his costs at every corner and there is no question but what a study of the fuel consumption in any plant will reveal the possibility of substantial savings.

In plants where gas is the major fuel, the piping system should be so arranged that all the gas produced in the plant can be burned before purchased gas is admitted to the system. In this way the cost of purchased fuel is reduced materially.

Gases from gas and vapor recovery plants and from pressure stills are high in heat value and will give high furnace temperatures when properly burned. Considerably more air is required for the combustion of these gases because of the presence of gases heavier than methane. For this reason, additional openings provided with adjustable doors are required in the furnace front.

Gaseous fuels lend themselves admirably to control at the burners by means of regulating valves operated by the steam pressure in the main header. Automatic damper controls used in connection with the gas control offer a splendid method for automatically maintaining the steam pressure at a given point.

In the event the gas controller is used without the damper controllers it is necessary to keep closer watch of load conditions. Otherwise a sudden increase in steam demand will result in a lowering of pressure which is compensated for by the automatic gas valve admitting more gas to the burners. The increase in volume of the furnace gases must be taken care of by the stack damper or incomplete combustion and dense smoking will result with a possibility of a backfire.

Fuel oil is a standard for refineries, especially during depressions of the fuel oil market when a comparison with other fuels on a B.t.u. basis will indicate whether it is more economical to burn or market the product.

This fuel varies greatly in its characteristics at different plants; slop oils, still residuums and other waste oils not readily saleable as fuels, often are utilized. The B.t.u. value of many of these waste oils is quite high.

Furnaces which will handle gas efficiently are equally efficient on the usual grades of fuel oil, changes in the air supply usually being necessary.

Whether burning fuel oil or not, it is useful to determine the relation in B.t.u. values of the fuel used to an average grade of fuel oil so that cubic feet of gas, tons of coal or coke, etc., may readily be converted to an equivalent amount of fuel oil in barrels. In this way, the per cent of fuel burned based on the still throughput is easily computed.

Coal presents no unusual conditions in refinery practice. It is usually burned on stoker grates and the same principles apply to its efficient combustion under stills as are recognized in any industrial process.

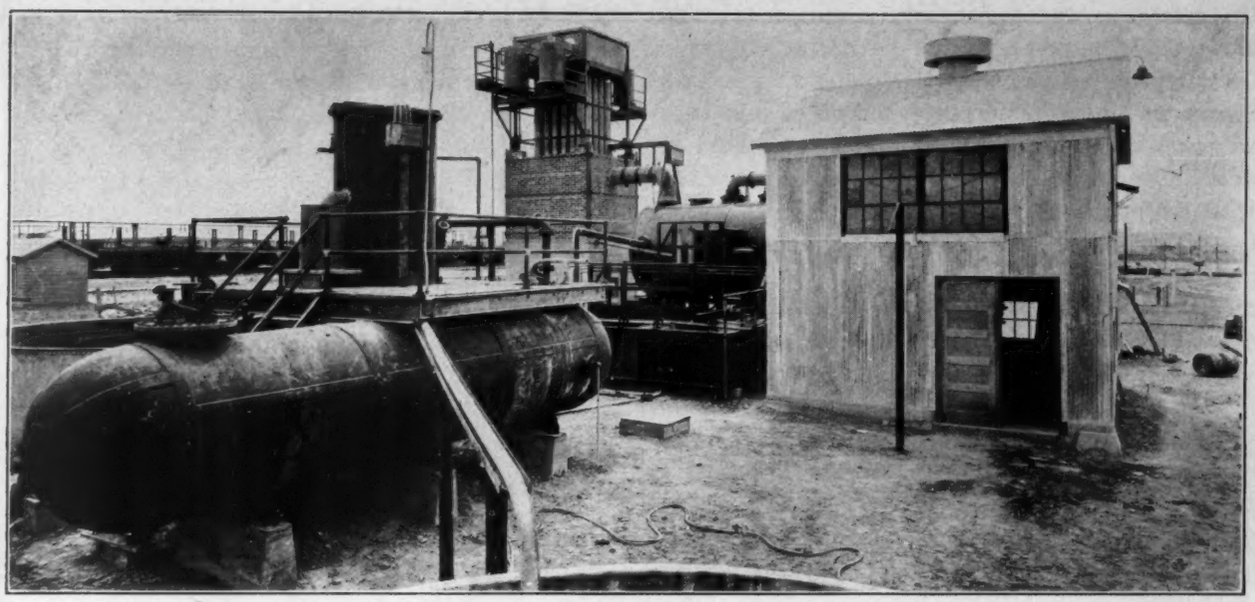
The burning of acid sludge containing varying amounts of moisture and foreign solids such as wood, wire, bolts, etc. has been receiving considerable attention and a few methods of utilizing its extremely high heat value have proved successful.

Naturally, the sulphurous gases have a detrimental effect on the equipment and the high furnace temperatures make maintenance of refractories rather expensive.

Pulverized petroleum coke is being burned successfully in a few plants, especially under boilers. This coke presents some aspects essentially different from pulverized coal. Although the coke does not vary greatly in chemical composition, there is to be found a wide variance in the burning qualities of two cokes. This is due to some minor differences in operation of the cracking equipment. Some coke may be more thoroughly saturated with oil, giving trouble in some types of pulverizers, however, it has been proved definitely that ordinary still-run coke can be handled economically without drying and with a minimum of maintenance on equipment.

Tarry residuums from pressure stills have never been successfully burned in quantities approaching the actual make per day although considerable research is being carried on by some manufacturers.

The principal trouble concerns the low temperature at which the volatile portions of the tar become ignited. Under these circumstances it has been impossible to maintain sufficient temperature to consume the carbon. Reducing the size of the lumps being fed to the burner and the direct application of an excess of air is giving better results and it may be that this by-product can be burned economically at least under boilers.



Outside view of drum type sulphuric acid concentrator, showing close-up view of pressure separator

The Sulphuric Acid Cycle

By PETER S. GILCHRIST
President, Chemical Construction Company, and Associates

SULPHURIC acid is utilized in oil refinery operations in a cyclic process, which may be divided into the following stages:

(1) Treatment of the oil with strong sulphuric acid, with production of acid sludge as by-product.

(2) Separation of the acid sludge to recover oil products and a weak separated sulphuric acid.

(3) Concentration of weak separated sulphuric acid to strong sulphuric acid, for re-use.

The acid lost in this cycle must be replaced with fresh strong acid, either purchased or manufactured by the refinery. When manufactured by the refinery, the new strong acid is preferably made in a contact system plant by fortifying the restored sulphuric acid with sulphuric acid anhydride (SO_3) and thereby reducing the excess free water content of the strong acid.

Treatment of the oil is primarily a refining problem and the oil industry has developed suitable equipment and methods as required for the different oils handled. The reclaiming of the acid sludge and the manufacture of additional fresh strong acid on an economical basis has been a problem at oil refineries, frequently neglected in favor of matters more directly related to the refining industry. This portion of the cycle has received careful study during recent years and a large number of sludge acid separating and concentrating plants and also plants for the manufacture of strong sulphuric acid by the new contact system have been installed. In general these plants comprise the following processes:

(A)—SEPARATION OF ACID SLUDGE

The proper method of separation is determined by the character of the sludge. A sludge resulting from the treatment of oils very high in aromatic or unsaturated compounds requires pressure separation. This is a continuous process in which sludge and water in the proper proportions are pumped into a cylindrical container, lined with lead and acid proof masonry. Live steam at 50 to 100 pounds pressure is introduced and acid oil and separated acid are removed continuously. The separated acid is at the high strength of 40° to 49° Be., thereby reducing the cost of subsequent concentration.

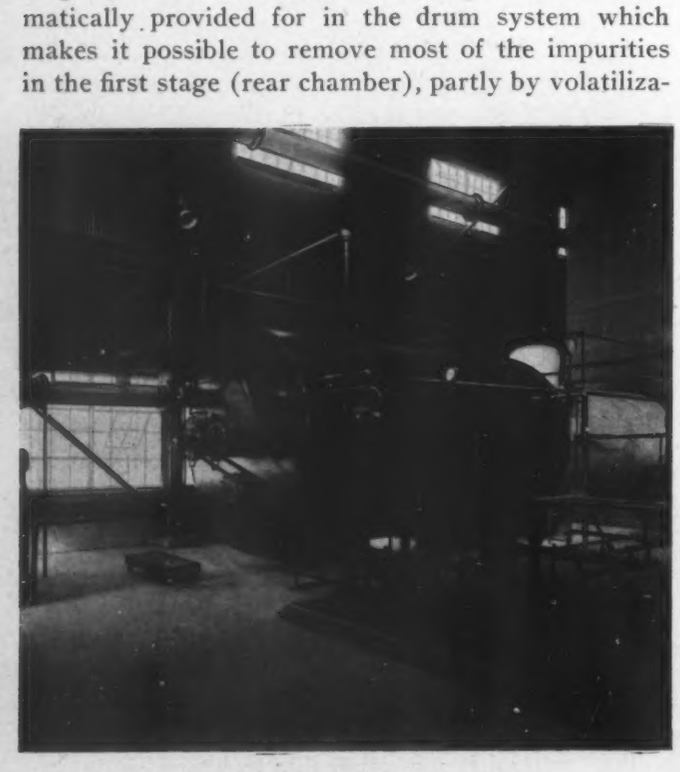
This method is not applicable to heavy sludges or sludges low in sulphonates. The open tank system

is necessary to obtain proper separation with sludges of this character and the separated acid produced is of 33° to 39° Be. strength.

The latest development in sludge acid recovery is the heat treatment under pressure of certain separated acids after the acid oil and tar have been removed. This process takes the acid immediately after it is drawn from the open tank or low pressure separators, and forces it through an apparatus much like the pressure separator where steam coils and direct steam at a pressure of 150 pounds bring the acid to a temperature of 350° to 360° F., thereby breaking down practically all the hydrocarbon compounds present in the separated acid. A concentrating yield of 94 per cent or better can be obtained from an acid so treated and all offensive odors are destroyed.

(B)—CONCENTRATION OF SEPARATED ACID

It is necessary to accomplish concentration at the lowest possible temperature because the acid is contaminated with carbonaceous materials which, in the presence of heat and strong acid, quickly cause the break-down of the acid, with the formation of SO_3 (sulphur dioxide). In the drum method the concentration is performed well below the normal boiling temperature of the acid. If it is necessary to concentrate the separated acid only to a low strength such as 60° to 62° Be., for use in connection with a contact acid plant as described below, still lower temperatures are possible, resulting in even less decomposition of the acid, higher yields and lower concentration costs. Furthermore, it has been found necessary to concentrate separated sludge acid in two stages in order to eliminate foaming. This is automatically provided for in the drum system which makes it possible to remove most of the impurities in the first stage (rear chamber), partly by volatilization and partly by oxidation so that a comparatively clean acid remains for higher concentration in the second stage (front chamber), which accounts for the high recovery obtained in this system.



Sulphur burning units

(C)—MANUFACTURE OF ACID

Sulphuric acid of the high strengths now required by refineries can only be economically made by the contact system. Formerly this system required the use of platinum as the catalytic agent with attendant difficulties and expenses that confined contact plants to only the largest refineries.

The use of Vanadium Contact Mass with a special converter system, and the spray sulphur burner, has simplified the contact system and today the first cost of a plant is considerably less than ever before. The operations are so simple that only one operator is needed per shift, in addition to one helper for bringing in sulphur. The yields are higher than have been customary previously in contact plant operation. Acid of any desired strength can be manufactured on a really economical basis.

Except in small refineries requiring less than 15 tons per day of fresh acid, it is ordinarily more economical to manufacture the acid in a modern contact system plant than to purchase it.

Another advantage of having a contact system operated in the refinery itself is that the separated acid need only be concentrated to a much lower strength in order to produce any desired strength of the total acid by fortifying with dry SO_3 in a contact plant, instead of by mixing with purchased acid, which must contain a considerable quantity of water, as is shown in the following table in which a cyclic efficiency of 66-2/3 per cent is assumed:

TABLE A

Case I.

Refinery requirements—30 tons per day, 93 per cent—H_2SO_4
Restored acid available—20 tons per day, "93 per cent—Equivalent"

Fortify with	A 93% Purchased	B 98% Purchased	C 104½% Purchased	D SO_3 Con. Plant
Source				
Actual tons fortifying acid required	10.00	9.49	8.90	7.59
Actual tons restored acid required	20.00	20.51	21.10	22.41
Strength of restored acid required	93.0%	90.7%	88.2%	83.0%

Case II.

Refinery requirements—30 tons per day, 98 per cent—H_2SO_4
Restored acid available—20 tons per day, "98 per cent—Equivalent"

Fortify with	A 98% Purchased	B 104½% Purchased	C 109% Purchased	D SO_3 Con. Plant
Source				
Actual tons fortifying acid required	10.0	9.38	8.99	7.99
Actual tons restored acid required	20.0	20.62	21.01	22.01
Strength of restored acid required	98.0%	95.1%	93.3%	89.1%

As separated acid cannot be satisfactorily concentrated to a strength of either 98.0 per cent or 95.1 per cent, it is impossible to operate according to either Case H-A or H-B. Even consistent concentration to a strength of 93.3 per cent (Case II-C) is very difficult, so fortification of concentrated restored acid with purchased acid to an average strength of 98 per cent is practically impossible un-

less an excessive ratio of purchased acid is used, which means either that the cyclic efficiency is less than 66-2/3 per cent or that the quantity of acid in the cycle is continually increased, either of which proceedings is economically undesirable.

(*Note: In actual practice a small amount of water will enter the contact acid plant from the moisture in the air used in combustion of the sulphur, so that the required strength of the restored acid to be fortified in the contact plant will be slightly above the theoretical figures shown for Cases I-D and II-D.*)

The savings in the cost of restoring acid possible by concentrating to a lower strength and fortifying in a contact plant can be developed from consideration of the relative amounts of water to be removed in the concentration. This also varies with the original strength of the separated acid and in Table B is shown the quantity of water removed from various strengths of separated acid to produce the quantities and strengths of restored acid required by the various cases in Table A. To simplify the comparison, a constant concentration yield of 100 per cent has been assumed; actually the yield would not be over 95 per cent in the most favorable cases and would decrease as the strength of the restored acid increases, resulting in even greater savings when concentrating to the lower strengths.

TABLE B

Case I.

Tons water evaporated to make 20 tons acid "93 per cent—equivalent."

Made as	A 93%	B 90.7%	C 88.2%	D 83.0%
Made from 32° Be. (37¼ per cent H_2SO_4)	29.92	29.41	28.82	27.51
Made from 34° Be. (40 per cent H_2SO_4)	26.51	26.00	25.41	24.10
Made from 41.4° Be. (50 per cent H_2SO_4)	17.20	16.69	16.10	14.79

Case II.

Tons water evaporated to make 20 tons acid "98 per cent—equivalent"

Made as	C 93.3%	D 89.1%
Made from 32° Be (37¼ per cent H_2SO_4)	31.59	30.59
Made from 34° Be. (40 per cent H_2SO_4)	27.99	26.99
Made from 41.4° Be. (50 per cent H_2SO_4)	18.19	17.19

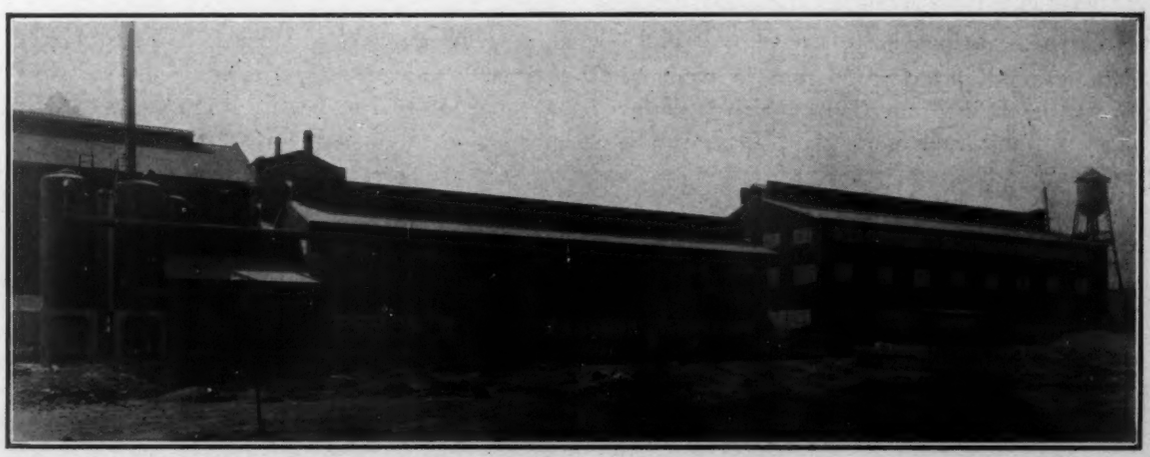
As direct concentrating costs, such as fuel, power, etc. are practically proportional to the water evaporated, it is obvious that these costs per ton "93 per cent, equivalent" would average about 12½ per cent less when concentrating to 83 per cent strength than addition, repairs and upkeep are considerably less and plant capacity is considerably greater when concentrating to the lower strengths, so that, while exact figures can not be disclosed, our experience is that total costs are about 20 per cent lower when concentrating only to 83 per cent strength.

As restored acid constitutes two-thirds of the total acid used in the cycle, it is obvious that the use of a contact plant at a refinery results in a reduction in acid costs, even if there were no saving in the cost of the fresh acid manufactured in the contact plant compared with the delivered cost of purchased acid. Except under very unusual circumstances, there will be a saving in the fresh acid cost also, so that the refinery with complete acid manufacturing and restoring plant operates its acid cycle much more economically than the refinery which purchases its make-up acid.

One of the most interesting installations of these plants was recently placed in operation at a refinery of one of the large American oil companies. This installation consisted of: Pressure separating units, drum type concentrating units, contact sulphuric acid plant, acid storage tanks.

These are all grouped together in one section of the refinery yard. The strong sulphuric acid, as needed for treating, is pumped to the refinery, after which the sludge is returned to the acid plants.

The sludge then enters the pressure separator where the acid is separated from the oil and tar. The oil is washed and neutralized and is then suitable for burning as fuel. The separated acid—40° to 45° Be. in strength—is then concentrated in a drum type unit to the desired strength—60° to 62° Be.—after which it is fortified in the contact plant and stored with the new acid, as 98 per cent H_2SO_4 or at any other suitable strength required for the refinery's use. The concentrators can deliver the acid at a strength as high as 66° Be., if desired. The exact strength depends on the water balance required in the contact plant.



Three contact sulphuric acid plants recently constructed

Production Costs and Product Costs

By R. E. KERFOOT
Cost Accountant

THE modern trend of business progression, with its speed and accuracy in mass production, has caused all in the industrial world, to think and to plan more constructively. Consequently the demand for greater production, at no increase in cost, has resulted in much extensive research by minds that are essentially alert and inquisitive.

The increased and constantly growing demand for refined oil products has brought about, in the last few years, a very high efficiency in the operation of newer designed and better constructed equipment, and with it, a greater knowledge and better understanding of the industry so necessary in our present day life.

Some manufacturers with a good outlet for their finished product, are apparently content to be satisfied with "production costs" rather than knowing "product costs." The latter information may, perhaps, not be especially necessary, if the product manufactured is not highly competitive. This information could easily be had, currently and accurately, if anticipated thought were given to that feature.

So it is with some refineries—they may be more or less content to know only the "production cost" of the plant as a unit, and may not give much thought to obtaining the cost per gallon of each product manufactured.

In the following data, a situation has been cited where two plants, working together, accomplish all that one complete plant should do, and which neither could do individually, if operating independently.

Plant "A" refines a particular type of crude oil, producing therefrom: gasoline, kerosene, gas oil, fuel oil.

All of the gas oil produced is sold to plant "B," where it is further refined, and from which is derived: gasoline, gas oil, and fuel oil. All of these products are sold to plant "A."

BOTH COSTS DEVELOPED

In the arrangement of the cost finding method, the production cost and the product cost are both automatically developed, and the comparisons over a period of time are an interesting guide to future operations. This data may also be the basis of an operating budget.

Application has been made in finding costs for plant "A," of the weighted selling ratio method; for under this plan, in fairness to all finished products obtained, each is considered a major product thereby eliminating the hazardous method of considering everything produced, other than gasoline, as by-products. It is true that the plant is operated for the production of gasoline, but the type of crude oil used permits the production of other finished oils, which have a very definite value in the open market.

Under this method production expenses, or costs, include the value of the crude oil consumed and the cost of operation (refinery expenses), the output or yield being divided on a basis of the marketable value of each product produced. In order that extraordinary price changes be given due consideration it is found equitable to use the average selling price over a 12-month period (applying this price to each product finished), to determine its relative value, or proportion, of the total production cost.

In the operation of plant "A" it is found by reference to data sheet, that a total of 270,000 barrels of crude oil was consumed at a total cost of $347,500.00; adding to this amount the total refining expenses of $10,750.00, gives the total production cost of $358,-250.00, or a total cost per barrel of $1.3268.

If this total production cost of $358,250.00 was applied to each of the individual products obtained on the basis of the yield per cents, the cost of the gasoline produced would be $71,650.00, or 20 per cent of the total, and the cost of fuel oil produced would be $143,-300.00. Such results would be entirely fallacious and quite without reason, as it would cost only $1.33 per barrel to produce gasoline, while the cost in producing a barrel of fuel oil would be $1.40, or nearly 50 cents per barrel more than the market value.

Analysis of selling prices of gasoline, over a year's period indicates that the average selling price was $2.52 per barrel. The prices used are not the current market at any given time, but the gross average of all gasoline invoiced by this company. That gives a tangible, comprehensive something to work with. Accordingly then, one finds that the yield of gasoline was 20 per cent of the crude oil consumed, or a total of 54,000 barrels. This quantity times the rate of $2.52 gives a product of $136,080.00.

PLANT "A"—PRODUCTION COSTS—SUMMARY FOR MONTH

	Barrels		Average Selling Price Previous 12 Months	Cost Factors		Amount	Cost Per Barrel	Cost Per Gallon
	Quantity	Per Cent to Total		Result of Two Previous Columns	Per Cent			
CONSUMED—								
Crude Oil Inventory—Beginning	70,000					$ 87,500.00	$1.25	
Crude Oil Purchased	280,000					358,400.00	1.28	
Total	350,000					445,900.00	1.274	
Deduct—								
Crude Oil Inventory—Ending	80,000					98,400.00	1.23	
Total Crude Oil Consumed	270,000					347,500.00	1.287	
Refining Expenses						10,750.00	1.287	
Total Production Cost						358,250.00	1.3268	
PRODUCED—								
Gasoline	54,000	20	$2.52	36,080.00	33.38	119,583.95	2.2145	.0517
Kerosene	40,500	15	1.89	76,545.00	18.77	67,243.52	1.6603	.0395
Gas Oil	64,800	24	1.26	81,648.00	20.02	71,721.65	1.1068	.0264
Fuel Oil	108,000	40	1.05	113,400.00	27.83	99,700.98	.9231	.0196
Loss	2,700	1	....	.....	.....	.....	....	....
Total	270,000	100	.....	407,673.00	100.00	$358,250.00		

Devised by R.E.Kerfoot

The same method is applied to kerosene, gas oil and fuel oil, and under these calculations the total is $407,673,000. The percentage that each product's value is of this total, is next developed.

GAS 33 PER CENT OF TOTAL

Gasoline is 33.38 per cent of that total, and by applying this per cent to the total production cost, the cost of gasoline is $119,583.95, or approximately, $0.0527 per gallon. This same process obtains in determining the costs of the other finished products, kerosene, gas oil and fuel oil.

It will readily be seen that any changes in yield of the individual products will not affect their relative cost, as their cost is based on value produced and not on quantity produced.

The determination of product costs at plant "B" is somewhat different however. Plant "A" takes plant "B's" entire output of finished products, and sells them with those produced in its own refinery. The current market price on gas oil, at the time of this report, is $1.15 per barrel, and represents the cost to plant "B." This, therefore, is the price applied to gas oil consumed, as well as that which is produced. The price that plant "A" will pay for fuel oil is $0.95 per barrel, and, accordingly, this is the price applied to the quantity produced in plant "B."

The production of gasoline is considered the main

PLANT "B"—PRODUCTION COST—SUMMARY FOR MONTH

	Barrels		Amount	Cost Per Barrel
	Quantity	Per Cent to Total		
CONSUMED—				
Gas Oil Inventory—Beginning	609		700.00	1.15
Gas Oil Purchased	68,696		79,000.00	1.15
Total	69,305		79,700.00	1.15
Deduct—				
Gas Oil Inventory—Ending	4,305		4,950.00	1.15
Total Gas Oil Consumed:	65,000		74,750.00	1.15
Refining Expenses			12,500.00	.1923
Total Production Cost			87,250.00	1.3423
PRODUCED—				
Gasoline	22,100	34	42,465.00	1.9215
Gas Oil	32,500	50	37,375.00	1.15
Fuel Oil	7,800	12	7,410.00	.95
Loss	2,600	4		
Total	65,000	100	87,250.00	

Devised by R.E.Kerfoot

factor in plant "B," therefore gas oil and fuel oil produced are termed by-products, there being no profit made from the sale of them, as they are costed at the same price for which they are sold.

By applying the current market prices, as mentioned above, to gas oil and fuel oil produced, the sum of these values so found, is deducted from the total production cost, the remainder representing the production cost of gasoline. This latter figure will, of course, absorb automatically, loss in refining. The cost of gasoline produced by plant "B" is $1.9215 per barrel, which is consistent with the operation, as gas oil is used as raw material at a lower price per barrel, while plant "A" is using crude oil at a higher price.

The resultant data from these various calculations provides the two desired elements—production cost in total, and product cost per barrel, or per gallon, either of which may be broken down further by analysis, to reflect other essential information, if requared.

A statement of sales and cost of sales, for plants "A" and "B," indicating the manner of determining net operating profit, accompanies this writing. In the cost section of the statement covering plant "A" operations, it will be noted that the purchases of refined products from plant "B" are stated separately, after cost of products refined, and giving consideration to beginning and ending inventories. This figure checks with the amount shown on plant "B" statement, under caption of sales.

Due to the arrangement between the two plants, namely, that plant "A" takes all the output of plant "B," they will not, then, have an inventory of refined products, and in their operations, cost of products refined and cost of products sold, are synonomous.

The plan, quite briefly outlined here, is one believed to be equitable in arriving at all costs, and it may be elaborated upon to whatever extent desired, yet be adapted to individual conditions and requirements where the demand for facts is warranted.

PLANT "A"—SALES AND COST OF SALES

Sales

Gasoline	$250,000.00
Kerosene	70,000.00
Gas Oil	103,000.00
Fuel Oil	120,000.00
Total	543,000.00

Cost of Products Refined and Sold

Crude Oil Consumed	347,500.00
Refinery Expenses	10,750.00
Cost of Products Refined	358,250.00
Beginning Inventory, Refined Oils	165,000.00
	523,250.00
Ending Inventory, Refined Oils	175,000.00
	348,250.00
Refined Products Purchased from Plant "B"	101,500.00
Cost of Products Sold	449,750.00
Net Operating Profit	$ 93,250.00

PLANT "B"—SALES AND COST OF SALES

Gasoline	$ 56,715.00
Gas Oil	37,375.00
Fuel Oil	7,410.00
Total	101,500.00

Cost of Products Refined and Sold

Gas oil consumed	74,750.00
Refinery expenses	12,500.00
Cost of products refined	87,250,.00
Beginning inventory, refined oils	.....
Ending inventory, refined oils	.....
Cost of products sold	87,250.00
Net operating profit	$ 14,250.00

Next Month

The October issue of REFINER AND NATURAL GASOLINE MANUFACTURER *which will be issued at the time of the International Petroleum Exposition will be especially devoted to a review of petroleum refining in Europe.*

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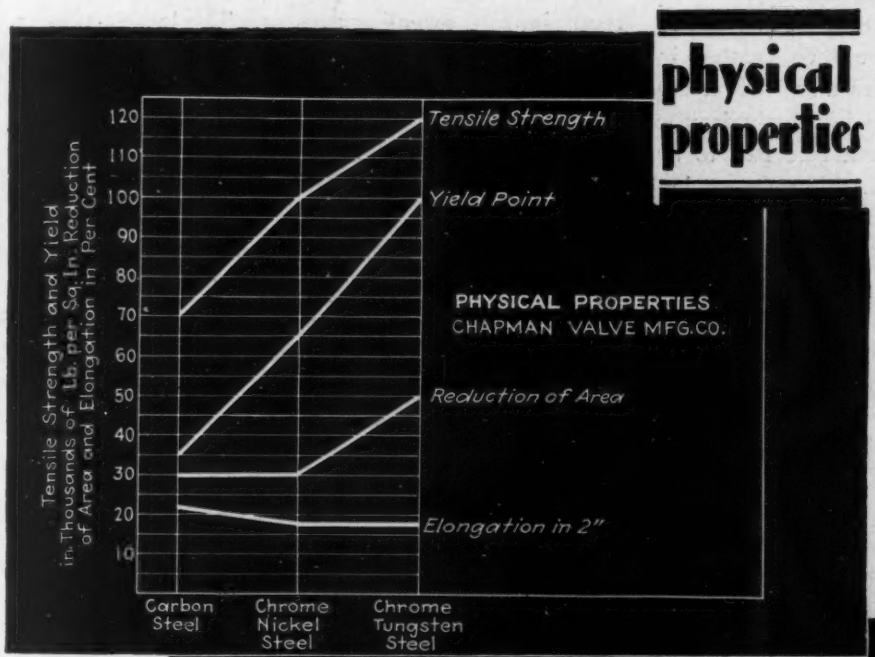

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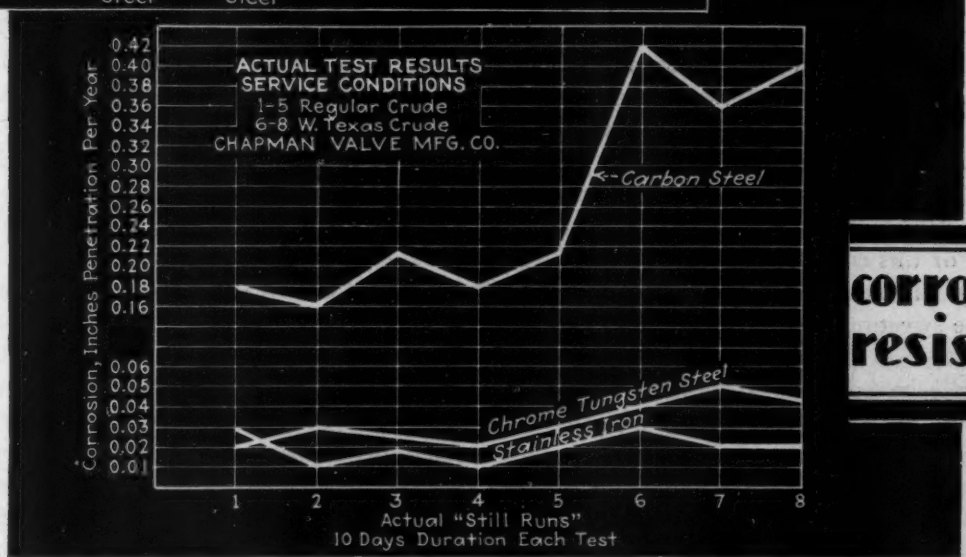


Practical Experiments on Sweating Paraffin

Translated from an article by Ewald Pyhaelae in Petroleum Zeitschrift, 1930, No. 5

THE dry sweating operation used in the production of paraffine is one of the most important processes in petroleum refining. This operation has for its purpose the removal of all oily ingredients that make the appearance of the refined paraffine milky. The removal of these constituents entailed in the past operations which took a great deal of time and necessitated tedious manipulations. Thus the crude paraffine was mixed in the molten state with benzine, allowed to solidify, cut into sheets, which were then treated in hydraulic presses. The oily impurities dissolved in the added benzine, which was then removed in the hydraulic press. It is clear that the crude paraffine had to be treated several times in succession in this manner, before it could be considered technically free from oil. Even though the paraffine may be refined in this manner so that all of the oily materials are removed, nevertheless it would still contain small quantities of benzine, which can be removed from the molten paraffine only by steam distillation. All these operations require special apparatus and much labor.

The introduction of the dry sweating process simplified the process to a great degree. The molten crude paraffine is introduced into the sweating apparatus and allowed to solidify there. The crude paraffine is fed by a pump into a reservoir located above the apparatus into which it flows. This operation is controlled by one operator, who can watch several machines at the same time. The economy of the process in this respect over the benzine process is evident. It has been stated that crude paraffine in the form of crystalline needles can be sweated, while crude paraffine in the form of small plates is not suitable for sweating.

The author has carried out a number of experiments in the paraffine factory in Baku, Caucasus to determine the correctness of this contention.

Before going into additional detail on the practical operation of the sweating process, which is limited only by regular increase of the temperature in the sweating chambers, it will be advisable to examine somewhat more closely the properties of the paraffine that is to be processed. As is well known the paraffine mass, obtained by filtration of the cooled paraffine oil, is allowed to congeal into layers of two to two and one-half-inch thickness, is then cut into sheets, which are then pressed under hydraulic pressure at the beginning at ordinary temperature, which is thereafter gradually increased. This results in the removal of the largest portion of the oily constituents of the paraffine. The modern method of removing the impurities from paraffine consists in a combination of the pressing and sweating process. The paraffine direct from the filter presses is fed under pressure by means of suitable pumps directly into the sweating presses. The largest portion of the oil contained in the paraffine is removed there, and the quantity of oil removed increases, the more skillful is the regulation of the gradually rising temperature in the presses. The quantity of oil in the crude paraffine varies according to the method used, that is whether hydraulic presses or sweating presses are employed.

The oil content of the crude paraffine is, however, of great practical importance in the subsequent stages of manufacture, that is in dry sweating. It is self-evident that the gradual rise of temperature during sweating is a condition that influences the loss of paraffine dissolved in the warm outflowing oil. This loss increases as the amount of oil in the crude paraffine increases. On the other hand, the crystalline form, in which the solid paraffine, present in the crude paraffine, crystallizes, also plays an important technical role in practical paraffine manufacture.

TYPES OF PARAFFINE

Two principal types of crude paraffine may be defined, namely, paraffine which crystallizes in the form of plates and paraffine which exists in the form of crystalline needles. It is easy to see on closer examination that when the crude paraffine consists naturally of crystals in the form of lamella, arranged horizontally in the mass, their oil content is easily removed from the paraffine as the temperature rises. This conclusion is substantiated by the consideration that the individual lamella hold back the oil just like a plate, without permitting very rapid outflow of the oil. On the other hand, when the crude paraffine consists of needle-shaped crystals, the oil is present in free state between the individual crystals, forming in the case of soft paraffine an easily melted, salve-like mass. This soft paste melts as the temperature rises and the oil flows very rapidly out of the crystalline structure, leaving

behind a structure which is quite free from oil. When the individual crystals melt together as the temperature is further raised, a sort of pressure results, in that the oily ingredients are pressed out between the liquating needles. Such a crude paraffine leaves behind in the sweating presses a so-called unrefined paraffine which is grayish white in color and which is practically free from oil, and this will in turn yield a dazzling white, transparent paraffine of the usual commercial grade on subsequent chemical purification and treatment with decolorizing agents.

However, the oil content of such crude paraffine is also important in that the paraffine content of the crude mass is correspondingly less, as well as in that a greater oil content causes a noticeable solvent action on the paraffine. This is particularly evidenced in the formation of very small, scarcely visible crystals which separate out from the crude paraffine. When this phenomenon is taken into consideration, the increase in the temperature, as soon as the rapidly outflowing fraction reduces in amount, should be brought about quickly up to a point two degrees below the melting point of the paraffine, for the purpose of accelerating the melting of the crystalline needles, which favors squeezing out the residual oil. This reduces the time of sweating. It must, therefore, be quite clear that a very slow rise of temperature, after the principal portion of the oil has been fractionally removed will only retard the sintering and other processes, and this will increase the time of sweating to a considerable degree. Such procedure must therefore be considered purposeless. In order to obtain a clear conception of the most favorable method for carrying out the sweating process, it is necessary in every case that the operator of the machines should be fully informed of the character and properties of the mass of paraffine that he is handling.

DETAILS ON PRACTICAL SWEATING TESTS

A series of experiments was carried out on a large scale in the Nobel paraffine plant in Baku. These experiments were made both with lamella-crystallized paraffine and crude paraffine existing in the form of small and large crystalline needles.

A conclusion which was obtained from the first series of experiments was that a crude paraffine, which crystallizes only in the form of lamella crystals, cannot be sweated by any process. The paraffine content of the crude paraffine plays no role in this connection. Even a comparatively small percentage of oil softens the entire mass and converts it into a condition where in it gradually melts. The cause of this is the absence of the needle crystals which are a necessary condition for the application of the sweating process.

The results of the second series of experiments, which were carried out on crude paraffine crystallized out in the form of scarcely detectable needles, were entirely different. The melting points of the crude paraffines indicated that they were of lower quality than those that were tested in the first series of experiments. Nevertheless, these paraffines could always be sweated, although the yield was not so good as in the third series of experiments, which were carried out on crude paraffines that crystallize out in larger, separated, needle-like crystals. The melting points of the latter paraffines were the same as those in the second tests. The conclusion was derived from these facts that a crude paraffine cannot be judged as far as its capacity for being sweated is concerned merely on the basis of its melting point. The fact is that much more consideration must be paid to the nature of the crystalline structure of the paraffine and its capacity to crystalize in the form of needles, which is a matter of the greatest technical importance. The yields which are given in tabulation number II substantiate the assumption that the minute needle crystals dissolve much more readily in the oils present in the crude paraffine, as the temperature rises, than the coarser crystals existing in the paraffines tested in the third series of tests. The difference in the yield is very greatly in favor of the crude paraffines which contain the larger needle crystals, being about double that of the crude paraffine containing the minute crystals with the same melting point. This circumstance is also of great technical and economic importance, for the larger the crystals, the better the yield. If this fact is borne strictly in mind, then it is easy to obtain good results in the operation of the paraffine plant. It de-

TABULATION NUMBER I.
Sweating Tests on Crude Paraffine Crystalized in Lamella Form

	Crude Paraffine			Paraffine Obtained				
Test No.	kgs.	Melting Point in Degrees C	Fraction in kg.	Kg.	Melting Point Degree C	Yield in Per Cent	Sweating Time in Hours	Remarks
1	5897	46-45.8	4914	983	..	16.6	144	
2	5225	44.8-46.8	4865	360	..	6.9	150	
3	5242	43	4914	328	..	6.5	155	Oily par-
4	5422	41.8-43	4930	491	..	9.0	150	affine ob-
5	5471	45.6-46	4980	491	..	9.9	105	tained,
6	5405	47	4947	458	..	8.5	160	unfit for
7	5733	47.6	5174	459	..	8.0	155	sale
8*	5600	58.8	5140	460	..	8.2	165	

*Crude paraffine obtained by distillation from ozocerite.

TABULATION NO. II.
Sweating Tests with Crude Paraffines Crystalizable in Scarcely Detectable Needles

	Crude Paraffine			Paraffine Obtained				
Test No.	kgs.	Melting Point in Degrees C	Fraction in kg.	Kg.	Melting Point Degree C	Yield in Per Cent	Sweating Time in Hours	Remarks
1	4963	43.8-44.2	4553	410	56.5	8.2	150	
2	5667	44.2-45	3783	1884	55.9	33.2	81	
3	5782	43.8-44.2	4144	1638	55.9	28.3	81	
4	6044	44.2-44.6	4324	1720	56.7	28.4	91	
5	5717	46.2-46.4	3588	2129	56.9	37.2	97	
6	5291	48.2-48.4	4243	1048	56.8	20.0	84	
7	4832	47.4	2194	1638	56.7	34.0	108	Oil con-
8	4570	45.4-46.5	3588	982	56.7	21.0	110	tent of
9	4914	47.4	3882	1032	56.8	21.0	125	crude
10	4914	48.8-48.6	3145	1769	68.0	36.0	135	paraffine
11-12	11188	47.4-47.8	8240	2948	56.9	26.3	...	22 per
13	4013	50.8	2621	1392	57.4	34.7	100	cent
14	5897	46.0-46.8	3997	1900	58.8	32.2	157	and 14
15	5242	46.4-46.6	3981	1261	58.4	24.0	167	per cent

serves special mention at this time that the formation of the needle-like crystals in the paraffine mass may be effected at will. (See Teknillinen Aikakauslehli Helinski, numbers 7 and 8, year 1917).

TIME ELEMENT

An examination of the time required to accomplish the sweating of the paraffine reveals the fact that the time of sweating is considerably longer in the case where crude paraffine, containing minute crystals, is being treated, than in the case of crude paraffine which crystals out in larger individual crystals. The reason for this also becomes quite evident, when it is called to mind that the oil which is present in the crude paraffine and which becomes warmer and warmer during the process, has the effect of a solvent on the paraffine. This circumstance also affords the operator a line on how to regulate his temperature increase as the process of sweating progresses. It is of course clear that the temperature of the sweating process must be regulated with considerably more care when the crude paraffine is made up of minute crystals than when it consists of larger crystalline structures.

(*It is well to use both recording and controlling thermometers in this operation. They have been found to be reliable instruments and are now made with great accuracy. Hand regulation of the temperature is only partially satisfactory, and where this is necessary it is best practice to use a recording thermometer to register the temperature throughout the process and thus check the operator. The author of this interesting article gives a number of tables in the original article in which are recorded the various temperatures observed during the sweating process, as taken from the record book of the operator on the job. Editor*).

In order to attain a definite conception of the manner in which the regulation of the temperature is interconnected with the proper cooling of the crude paraffine to crystallization during the sweating process, so that as high as possible yield of unrefined paraffine can be obtained, it is necessary to examine somewhat more closely the crude paraffine filled into the sweating troughs or pans during its chilling and conversion into solid cakes. It must be evident without discussion that the procedure of the sweating process depends on the properties of the crude paraffine, particularly on the manner in which the mass is crystalized. The regulation of the temperature accordingly depends on the behavior of the congealed crude paraffine and this refers to the temperature that exists in the sweating press. Furthermore, the manner in which the crude paraffine absorbs the heat that is added to it must also be taken into consideration.

The paraffine, which has been brought up to a temperature of 60 to 70C. in the sweating pans due to heat conducted to from hot water heating coils or jackets, is cooled down by stopping the flow of hot water and allowing ordinary tap water to flow through the coils or jacket. The temperature of this water is that of the outer air. Inasmuch as the cooling water is added separately to each pan, the crude paraffine is simultaneously solidified in all the pans.

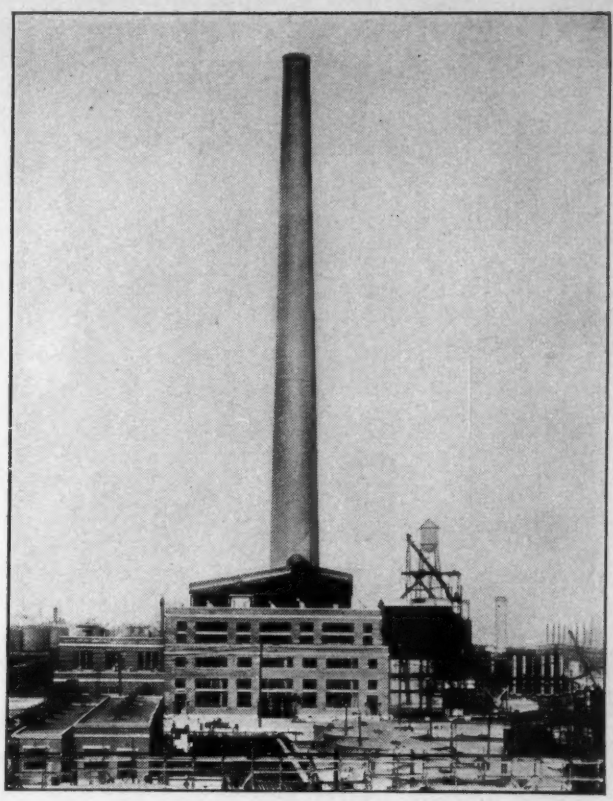
Thus when the cooling process is carried out in this manner with the aid of cooling water which has a temperature of 6 to 7 degrees C., the crude paraffine is completely solidified within a period of 16 hours. The temperature of this paraffine is approximately 24 to 25 degrees C. and the wax becomes cooler as it is allowed to remain in the pan, the temperature being reduced at the rate of one degree Centigrade per hour at the beginning and later at the rate of half a degree Centigrade per hour. After the crude paraffine has been allowed to remain in the pans for 25 hours, its temperature varies between 18 to 22C. If the crude paraffine has a tendency to form needle crystals, then it is found that this crystalline structure has definitely developed, with the result that the oily ingredients, mixed with the soft paraffine, sinks to the bottom of the pan. Quite white networks of crystals can often be seen on the surface of the cake of wax, which appears to be quite free from oil at this point.

If the temperature is very slowly raised during the beginning of the sweating process, the fractionation of the oily ingredients is retarded. The result is that the oily ingredients remain in contact with the crystallized paraffine longer than necessary. The oils have a strong solvent action on the paraffine as the temperature rises. The result is that the fractions, that flow off, have a comparatively high melting point and the paraffine has to remain longer in the sweating presses in order to become free from oil.

On the other hand when the sweating of the same type of paraffine is accomplished as rapidly as possible, which means that the temperature is rapidly increased at the beginning of the process, then the very easily melting oily ingredients which sink to the bottom during the process of crystalization run off quickly. This takes place in such a manner that, as soon as the rather thin, under-skin of the crude paraffine cake melts, the oily impurities, which are already present in the liquid condition in the crystalline structure, run off very quickly. It is clear that the fractionation process takes place very quickly even at the start of the sweating, when the latter is carried out as above. The result is that these oils do not have an opportunity to dissolve appreciable quantities of paraffine and hence their congelation point is comparatively low.

CONGEALING POINT

This fact is substantiated by the observation that the paraffine in the pans are quite free from oil, due to the removal of the principal portion of the oily ingredients heretofore. Hence the paraffine has a congelation point of over 50°C. This paraffine which has become condensed in molten state squeezes out the last traces of oil without much difficulty and allow the latter to run off. The fractionation process is always much less in this



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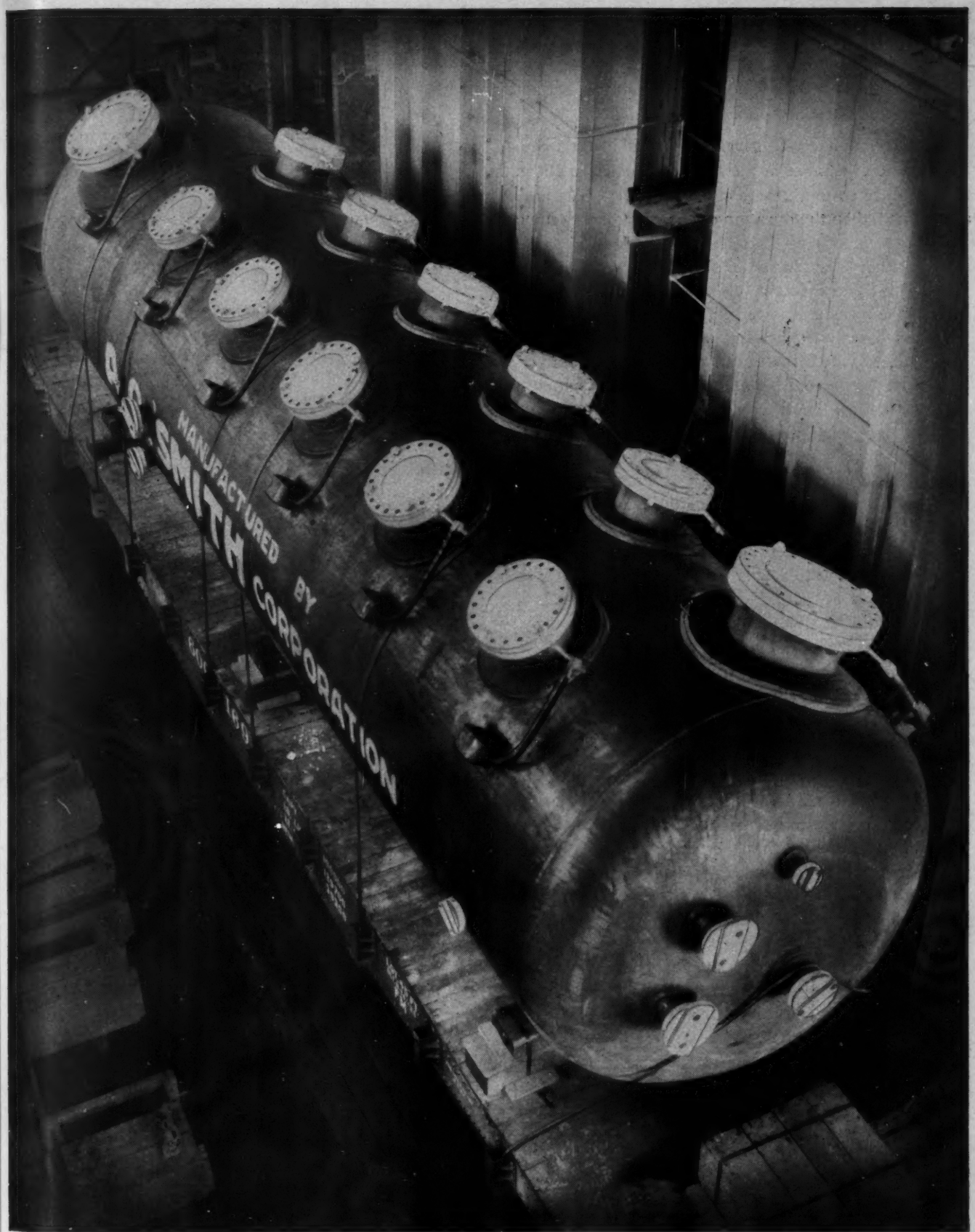

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CRACKING STILLS

stage of the sweating process, and eventually fractionation ceases altogether. This is an indication that the paraffine is ready to be melted down. When the sweating operation is accomplished in this manner, satisfactory yields of unrefined paraffine are obtained.

However, if a crude paraffine, which has a distinct tendency to crystallize in the form of needles, is allowed to crystallize so that needle crystals as large as possible are formed, then the duration of the crystallization must be correspondingly increased. In this instance the cooling operation is conducted in such a manner that solidification first takes place after 45 hours and the temperature of the mass is between 28 and 29C. This condition is obtained by not pumping any cooling water at all through the jacketed pans, but allowing the warm water in the jackets to cool off naturally. Under such conditions crystallization takes place at the bottom of the mass of paraffine, and masses of smaller crystals form from this point upward, while the mass of oily impurities, which fill out the intervening spaces, appear to be uniformly distributed throughout the mass of wax. A transparent and very thin skin forms on the surface of the crude paraffine wax. Very long, perpendicular, water white separate crystals hang down from the surface skin into the mass of paraffine. These needle crystals are thicker at the surface skin, but become narrower as they extend down and finally end in a point. If a section is cut out of the cake of wax, before the oil mass, which fills the intervening spaces, as mentioned above, solidifies, then the oily substances flow out and needle crystals are obtained, as may be seen from Fgure 1.

The next point that must be discussed is the variations in the thermal condition of the mass of crude paraffine as it cools off naturally and also during the sweating process. It is verified that the temperature of the mass of crude paraffine wax, which is cooled off in the manner described, falls very slowly. The temperature hence decreases approximately one-third of a degree Centigrade per hour during the first three hours of cooling. Thereafter the decrease is somewhat more rapid, being approximately one degree Centigrade within the same time period. This goes on until a temperature of 52°C. is attained in the mass. Thereafter, the temperature again decreases more slowly at the rate of one-half to one degree Centigrade per hour, until a temperature of 40° to 41°C. is attained. After that point, the temperature again decreases more slowly, the rate being only one-half a degree Centigrade within a period of two hours. After the temperature of the paraffine wax has reached a point of 37°C. it drops again at the rate of one-quarter of a degree Centigrade per hour. The rate of decrease of temperature is again accelerated after it once attains 30°C., the rate being in this case 1°C. per hour. The temperature of the crude paraffine, which was allowed to cool off in this manner, was 26°C. within a period of eight five hours. During all this time the paraffine mass was allowed to come into contact with the air although it was not removed from the apparatus. The temperature of the outer air during this time amounted on the average to + 6.8°C.

Inasmuch as the temperature increases quite rapidly at the start of the sweating process, the greatest portion of the fractions can be obtained at a temperature of 45° to 49°C., which means within the first nine to a maximum of 18 hours or within a period of 24 to 39 hours according to the crystalline structure of the crude paraffine mass. The flowing off of oil, which is squeezed out of the oil, as mentioned above, due to the pressure exerted by the paraffine as it melts, takes place during the remainder of the time that the paraffine is processed.

As soon as the temperature within the apparatus attains 42.4°C., the temperature of the crude paraffine in the apparatus attains only 36°C., while the temperature of the outflowing fractions is 33 to 34°C. At a temperature of 44°C. within the apparatus, the paraffine mass has a temperature of only 36.5°C. and at 44.5° to 45.0°C. only between 37° and 37.5°C., while the temperature of the outflowing fractions is 36.5° to 37.5°C. At a temperature of 45.5°C. the temperature of the paraffine is 37.5° to 41°C., and that of the fractions 38.5° to 39°C. At a temperature of 45.7°C., in the apparatus, that of the mass is 37.5° to 41.5°C. and that of the fractions 39° to 39.5°C.; at 46°C. that of the paraffine 39° to 42°C., that of the fractions 39° to 39.5°C. When the temperature within the apparatus is raised to 48°C., the temperature of the paraffine mass is 42° to 43.5°C. and that of the fractions 46° to 47°C.; at 46° to 47°C., in the apparatus, the temperature of the paraffine is 44.5° to 46.5°C., and that of the fractions 49° to 50°C. At a temperature of 49.2°C. in the apparatus, the mass is 46.5° to 47.5°C., the fractions 49.5° to 50°C.; at 49.6°C., the mass is 46.5° to 48°C., the fractions 49.5° to 51°C.; at a temperature of 51.2°C., the mass is at 48.5° to 49°C., and the fractions at 51°C.

The aforementioned variation in temperature affords very interesting and valuable information from the standpoint of the regulation of the increase in temperature during the sweating of paraffine. These temperatures indicate that at the start of the sweating process the increase of temperature in the paraffine cannot duplicate that in the apparatus, and even less so that of outflowing fractions. However, the more the temperature of the apparatus gets closer to the melting temperature of the sweated paraffine, the smaller the difference between the two temperatures becomes. This condition sets in only after long sweating, when the principal amount of sweating fractions has run off and the paraffine is in a molten mass. When the temperature difference amounts to 6°C., at the beginning the sweating period, it is only one to two degrees Centigrademore at the end. This explains why the increase in temperature at the beginning of sweating must be as rapid as possible, and after this the crystalline structure of the crude paraffine requires slower regulation of the temperature and finally its maintenance for a protracted period a few degrees below the melting point of the mass.

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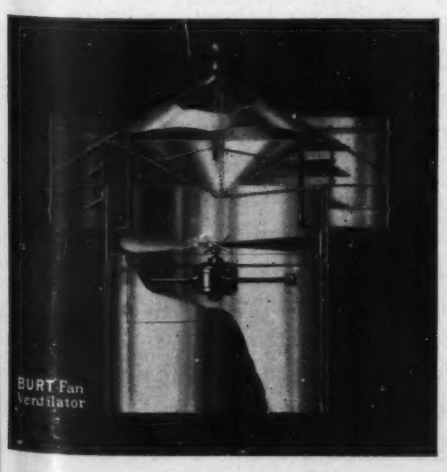

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Few Concerns Dominate Refining Capacities

By GEORGE REID
Associate Editor

THE position of the larger integrated companies operating refining facilities in the United States has been materially strengthened through continued expansion and additions during the past year. The 22 companies dominating the refining industry in capacity of crude throughput and cracking equipment now have 79.79 per cent of the total rated refining capacity and 87.62 per cent of the total rated cracking capacity of the United States. In addition, these 22 companies possess 85.56 per cent of all cracking units, operating 29 of the total of 38 different processes used in the industry in America.

Seventeen of the companies analyzed at this time and included in the list of the largest refining organizations are stockholders in the newly formed Hydro Patents Company, thus indicating their interest in the hydrogenation process. The combined total domestic crude refining capacity of these 17 companies, practically all of which are investigating the possibilities of hydrogenation by actual study of the process in operation in Germany and this country, is 2,446,450 barrels daily. This is approximately equivalent to two-thirds of the refining capacity of the United States, based on latest available capacity figures as reported to the Bureau of Mines.

The refining industry as a whole has been engaged in an enlargement and development program during the past two or three years which has resulted in the present condition of over-production of refining facilities and brought about a situation where the total daily capacity of plants as compared to total daily crude throughput is much too large. There has, however, been no abating of activity during the past few months in so far as the continued provision of additional capacity is concerned. Each month has seen the announcement of a number of new refining installations.

TWENTY-TWO companies have 80 per cent of the total crude capacity and 87 per cent of the cracking facilities in the United States.

These 22 companies have 159 refineries and 1713 cracking units. The remainder of the refining capacity, about 20 per cent, is divided among about 275 plants owned by close to 250 companies. These companies possess about 290 cracking units.

The refining industry, like several other industries, is dominated by a score of companies, but compared to such other industries as the automotive, public utility, and steel, the petroleum refining industry is divided among a relatively large number of competitive units.

The 22 companies included in Table 1 and termed the leading or largest refining organizations have, for the most part, recently completed, or are now completing expansion and development programs. The greater portion of this work has involved the installation of modern distillation equipment displacing obsolete facilities, but at the same time effecting marked increases in crude capacity. Other than skimming plant enlargement incidental to the installation of the modern equipment, these same companies have at the same time provided cracking facilities to the end that the total cracking capacity of the group has been materially increased to the point where 1713 cracking units, out of a total of 2002, are owned by this group and these units represent a capacity of 1,497,475 barrels per day. This is 87.62 per cent of the total cracking capacity in this country (1,708,940 barrels)*

This concerted effort on the part of this group of refiners during the past year toward rapid expansion of their cracking facilities is attributed to the growing demands for premium grades or non-detonating motor fuels. At the same time utilization of pyrogenic equipment is a factor of no little importance in the general trend toward conservation of crude petroleum. Roughly, the cracking process is responsible for an increase in gasoline production of 15 per cent, over that secured by skimming plant methods. This additional recovery contributed much to the improved quality of the general run of motor fuels. Demands of the motorists, necessitating increased production of anti-knock motor fuels while their numbers continue increasing annually, and the rapidly growing aviation industry has contributed to the needs for cracking processes and their utilization in the preparation of premium motor fuels.

The 22 companies listed in Table 1 have so rapidly

*See note page 106.

ANALYSIS OF REFINING FACILITIES OF TWENTY-TWO LEADING MANUFACTURING COMPANIES IN THE UNITED STATES

Material Sources—Bureau of Mines, Information Circulars 6292 and 6305 as of January, 1930

Company—	Number of plants	Reported rated crude capacity barrels daily	Reported rated cracking capacity barrels daily	Reported number of cracking units	Reported Number and types of cracking units	Hydrogenation Interests
Standard Oil Company of New Jersey and three subsidiaries	13	529,500	289,000	120	96—Tube and Tank (4 shut down) 20—Link. 4—Cross	Stockholder Hydro Patents Company. 1 unit operating, 2 building
Standard Oil Company (Indiana) and four subsidiaries	13	270,500	220,575	740	683—Burton (488-S.D.), 1—Cross 2 High Pressure, 34—Holmes-Manley	Stockholder Hydro Patents Company.
Shell Union Oil Corporation and two subsidiaries	9	259,000	121,500	71	67—Dubbs, 2—Cross, 1—Converter 1 True Vapor Phase	Stockholder Hydro Patents Company.
Standard Oil Company of New York and three subsidiaries	15	245,000	91,000	104	32—Cross: 1—Vapor Phase (S.D.) 68—Burton, 1—White Eagle 7—Holmes-Manley, 1—Jenkins	Stockholder Hydro Patents Company.
Standard Oil Company of California and two subsidiaries	5	245,000	58,000	26	20—Dubbs, 6—Richmond	Stockholder Hydro Patents Company.
Gulf Oil Corporation and one subsidiary	7	224,000	107,900	100	2—Dubbs, 4—Holmes-Manley* 93—Buerger, 1—De Florez	None reported
The Texas Corporation and one subsidiary	21	212,500	145,100	97	83—Holmes-Manley, 1—Vapor Phase 11—Pressure Coke, 1—Cross 1—Tube and Tank	Stockholder Hydro Patents Company.
Total—first seven companies—and subsidiaries (23 companies) .	83 19.76 per cent of total	1,985,500 52.21 per cent of total capacity	1,033,075 60.45 per cent of total capacity	1,258 62.83 per cent of total		
Tide Water Associated Oil Co. and three subsidiaries	8	157,500	14,000	17	7 Tube and Tank, 10—Burton	None reported
Sinclair Consolidated Oil Corp. and two subsidiaries	13 (3-S.D.)	156,450	111,100	115	100—Isom, 4—Dubbs, 4—Cross	Stockholder Hydro Patents Company.
Richfield Oil Co. of California..	5	129,000	30,000	16	4—Cross, 12—Black	None reported
Union Oil Company of California	6	106,900	37,000	9	7—Cross, 1—Leintz 1—Carborundum	Stockholder Hydro Patents Company.
Total—Second four companies—and subsidiaries (nine companies)..	3	549,850	192,100	157		
Total—First and Second Group—11—companies (32 companies) Importance of Group—	115 27.38 per cent of total	2,535,350 66.67 per cent of total capacity	1,225,175 71.09 per cent of total capacity	1,415 70.67 per cent of total		
Atlantic Refining Company	4	72,000	43,600	24	4—De Florez (bldg.) 18—Cross, 2—Lewis	Stockholder Hydro Patents Company.
Pure Oil Company	6	71,500	47,200	53	17—Gyro, 32—Cross, 4—Dubbs	Stockholder Hydro Patents Company.
Cities Service Company and swo subsidiaries	8	61,600	26,000	21	16—Doherty, 4—Dubbs 1—Holmes-Manley	Stockholder Hydro Patents Company.
Continental Oil Company	8	56,500	31,500	48	24—Burton, 14—Dubbs, 10—Cross	Stockholder Hydro Patents Company.
Sun Oil Company	3	42,000	42,000	15	9—Cross, 6 Sun (Own)	None reported
Standard Oil Company of Ohio and one subsidiary	3	42,000	17,500	7	7—Tube and Tank	Stockholder Hydro Patents Company.
Mid-Continent Petroleum Corp. .	1	40,000	18,500	84	4—Koontz, 80—Coast (10-S.D.)	Stockholder Hydro Patents Company.
Louisiana Oil Refg. Corp.	3	35,000	12,500	9	9—Tube and Tank	None reported
Vacuum Oil Company and one subsidiary	3	30,000	9,000	14	5—Cross, 4—Tube and Tank 1—Pratt, 4—Fleming	Stockholder Hydro Patents Company.
Skelly Oil Company	2	28,000	15,500	13	1—Pipe Still, 12—Jenkins (6S.D.)	Stockholder Hydro Patents Company.
Barnsdall Corporation	3	20,000	9,000	10	4—Dubbs, 6—Cross	Stockholder Hydro Patents Company.
Total—Third Group of 11 companies (15 companies)....	44	498,600	272,300	298		
Grand Total—22 companies (owning 47 companies)	159	3,033,950	1,497,475	1,713		17 company stockholders in Hydro Patents Company.
Percentage of United States total Percentage of operating total...	37.85 44.41	79.79 83.4	87.62	85.56		
United States Totals—operating	358	3,637,825 operating	1,708,940	2,002		
United States Totals—total plants	420	3,802,785 total				

*Not B. of M-I.C. 6305.

enlarged their cracking departments to the end that total capacity for the group has increased 38 per cent above the capacity of the same group a year ago. Last year in a similar analysis published in THE REFINER AND NATURAL GASOLINE MANUFACTURER, issue of July, page 57, this group of companies had a reported total cracking capacity of 1,194,407 barrels per day, which at that time was 80.87 per cent of the total in this country. The same companies this year have a reported total cracking capacity of 1,497,940 barrels per day, an increase of 472,540 barrels, or 38 per cent.

In this survey it is found that 22 companies control through subsidiaries a total of 47 companies, and operate 159 refineries in this country, having 1713 cracking units. In Table 1 the list of companies is shown, followed by the number of refineries, the reported rated capacity of these plants, the reported rated capacity of the cracking departments, number and types of cracking processes, and interests in the hydrogenation process through stock ownership in Hydro Patents Company.

While the 47 companies operate 159 refineries, which is 44.41 per cent of the operating plants and 37.85 per cent of the total refineries in this country, there remains 276 refineries in the United States which are owned by about 240 companies. Such a large number of smaller units in the industry again brings to notice that fact that while the petroleum industry, like several others, is dominated by a score of larger organizations, compared to such other industries as the automotive, public utility, and steel, the petroleum refining industry is divided among a relatively large number of competitive units.

The analysis of company holdings as presented at this time is based on

STANDARD OIL COMPANY OF NEW JERSEY

Company—	Rated Crude Capacity Bbls. Day	Rated Cracking Capacity Bbls. Day	Number and Type of Cracking Units January 1, 1930
Standard Oil Company of New Jersey			
Baltimore	32,000	22,000	10—Tube and Tank
Bayonne, Jersey City and Linden, New Jersey, three plants	180,000	77,000	31—Tube and Tank
Charleston, S. C.	15,000	13,500	8—Tube and Tank, 4 S. D.
Parkersburg, W. Va.	5,000	4,500	2—Tube and Tank
	232,000	117,000	51—Tube and Tank, 4 S. D.
SUBSIDIARIES			
Humble Oil & Refining Company			
Baytown, Texas	125,000	65,000	20—Tube and Tank 2—Cross
Breckenridge, Texas	1,500	....	
Chilton, Texas	4,500	....	
Ingleside, Texas	15,000	6,000	2—Tube and Tank
McCamey, Texas	15,000	6,000	2—Tube and Tank
San Antonio, Texas	4,500	....	
Neches, Texas	5,000	....	
	170,500	77,000	24—Tube and Tank 2—Cross
Colonial-Beacon Oil Company			
Everett, Mass.	27,000	25,000	13—Tube and Tank
Standard Oil Company (Louisiana)			
Baton Rouge	100,000	70,000	20—Link 8—Tube and Tank
	127,000	95,000	2—Cross
Total—Standard Oil Company of New Jersey—13 plants	529,500	289,000	96—Tube and Tank, 4 S. D. 20—Link, 4—Cross

STANDARD OIL COMPANY (INDIANA)

Standard Oil Company (Indiana)			
Wood River, Ill.	30,000	28,000	60—Burton—40 shut down 6—Holmes-Manley
Whiting, Indiana	90,000	95,200	166—Burton—106 shut down 2—High pressure 22—Holmes-Manley
Sugar Creek, Mo.	14,500	22,400	80—Burton—60 shut down 4—Holmes-Manley
Milwaukee, Mich.	1,500	....	
Casper, Wyoming	....	47,885	247—Burton—197 shut down
	136,000	193,985	553—Burton—403 shut down 2—high pressure 32—Holmes-Manley
SUBSIDIARIES			
Mexican Petroleum Corporation			
Baltimore, Md.	8,000	....	
Destrahen, La.	30,000	....	
Savanah, Ga.	5,000	....	
	43,000	....	
Mid-West Refining Company			
Casper, Wyo.	65,000	6,200	40—Burton—shut down
Greybull, Wyo.	13,000	4,680	40—Burton
Laramie, Wyo.	5,000	3,100	20—Burton—15 shut down
	83,000	13,980	100—Burton—55 shut down
Utah Oil & Refining Company			
Salt Lake City	6,000	10,200	30—Burton—shut down 2—Holmes-Manley
Dixie Oil Company			
Superior, La.	4,500	2,500	1—Cross
	10,500	12,700	30—Burtons—shut down 1—Cross, 2—Holmes-Manley
Total—Standard Oil Company (Indiana)—13 plants	270,500	220,575	683—Burton—488 shut down * 2—high pressure 1—Cross—34 Holmes-Manley * 70,260 Bbls. Burton shut down

SHELL UNION OIL CORPORATION

SUBSIDIARIES			
Shell Oil Company (California)			
Martinez, Cal.	30,000	11,500	8—Dubbs, 1—Converter
Watson & Dominguez	62,000	40,000	16—Dubbs
Coalinga, Cal.	4,000	....	
	96,000	51,500	24—Dubbs, 1—Converter
Shell Petroleum Corporation			
Wood River, Ill.	46,000	30,000	1—True Vaper Phase 14—Dubbs 2—Cross
East Chicago, Ind.	27,000	10,000	8—Dubbs
Arkansas City, Kansas	20,000	10,000	9—Dubbs
Norco, Louisiana	20,000	10,000	6—Dubbs
Houston, Texas	20,000	10,000	6—Dubbs
	133,000	70,000	43—Dubbs, 2—Cross 1—True Vapor Phase
Shell Eastern Petroleum Products Company			
Fall River, Mass.	30,000	....	
Total—Shell Union—Nine plants	259,000	121,500	67—Dubbs, 2—Cross 1—Converter 1—True Vapor Phase

(Continued on next page)

STANDARD OIL COMPANY OF NEW YORK

Standard Oil Company of New York			
Greenspoint, N. Y.	19,000	8,000	6—Cross
Buffalo, N. Y.	5,000	2,000	2—Cross
Providence, R. I.	10,000	6,000	3—Cross
	34,000	16,000	11—Cross
SUBSIDIARIES			
Magnolia Petroleum Company			
Beaumont, Texas	65,000	58,500	20—Cross, 48—Burton
Magpetco, Texas	10,000	....	
Luling, Texas	2,000	....	
Corsicana, Texas	3,000	....	
Fort Worth, Texas	5,000	2,000	1—Cross
	85,000	60,500	21—Cross, 48—Burton
General Petroleum Corporation			
Vernon, Cal.	55,000	3,000	1—Vapor Phase—shut down
Lebec, Cal.	12,000	....	
Olinda, Cal.	3,000	....	
Torrance, Cal.	35,000	....	
	105,000	3,000	1—Vapor Phase—Own S. D.
White Eagle Oil Corporation			
Fort Worth, Texas	3,000	2,000	1—Holmes-Manley
Augusta, Kans.	12,000	5,000	20—Burton
Casper, Wyo.	6,000	4,500	1—White Eagle, 1—Jenkins
	21,000	11,500	1—Holmes-Manley 2—H. M., 1—Own, 1—Jenk 20 Burton
Total—Standard Oil Company, New York—15 plants	245,000	91,000	32—Cross, 68—Burton, 1—Vapor Phase 1—Jenkins, 1—White Eagle 1—Holmes-Manley

STANDARD OIL COMPANY OF CALIFORNIA

Standard Oil Company of California			
El Segundo, Cal.	100,000	32,000	12—Dubbs 4—Richmond
Richmond, Cal.	100,000	20,000	8—Dubbs
Bakersfield, Cal.	25,000	....	
	225,000	52,000	20—Dubbs, 4—Richmond
SUBSIDIARIES			
El Paso, Texas	10,000	4,000	1—Richmond
Paso-Tex Refining Corporation			
Col-Tex Refining Company (62½ per cent owned)			
Colorado, Texas	10,000	2,000	1—Richmond
	20,000	6,000	2—Richmond
Total—Standard Oil Company, California—5 plants	245,000	58,000	20—Dubbs, 6—Richmond

GULF OIL CORPORATION

SUBSIDIARIES			
Gulf Refining Company			
Bayonne, New Jersey	30,000	1,200	1—DeFlorez
Girard Point, Penn.	40,000	8,000	4—Buerger
Fort Worth, Texas	5,000	4,200	6—Buerger
Port Arthur, Texas	125,000	87,500	81—Buerger
Sweetwater, Texas	5,000	4,000	2—Buerger
	205,000	104,900	93—Buerger, 1—De Florez
Union Gulf Corporation			
Pittsburgh, Penn. (Bldg.)	3,000	....	No report
(Paragon) Toledo, Ohio	16,000	3,000	2—Dubbs
	19,000	3,000	2—Dubbs
Total—Gulf Oil Corporation—Seven plants	224,000	107,900	93—Buerger, 1—De F., 2—Dubbs

TIDE WATER ASSOCIATED OIL COMPANY

SUBSIDIARIES			
Associated Oil Company			
Avon, California	60,000	....	
Martinez, California	10,000	....	
Watson, California—Two plants	18,000	....	
Taft, California	1,500	....	
	89,500	....	
Tide Water Oil Company			
Bayonne, N. J.	50,000	9,000	4—Tube and Tank
Tidal Refining Company			
Drumright, Okla.	15,000	5,000	3—Tube and Tank, 10—Burton
Tidal Western Oil Company			
Burkburnett, Texas	3,000	....	
Total—Tide Water Associated—Eight plants	157,500	14,000	7—Tube and Tank, 10—Burton

(Continued on next page)

U. S. Bureau of Mines Information Circulars 6292 (Refineries) and 6305 (Cracking Plants). The companies are grouped according to capacities and in that sequence, making three groups such as: First Group, capacity range from 200,000 barrels per day upwards, into which classification seven companies fall, as against six last year. The second group consists of companies having reported refinery capacity ranging from 100,000 to 200,000 barrels. There are four companies in this section of the table, as compared to five last year, and this for the reason that Gulf Oil Corporation, through the purchase of Paragon Refining Company, the formation of Union Gulf Corporation, and increases at its other plants, has increased its reported refining capacity from 197,000 barrels per day to 224,000 barrels daily. The third group consists of those concerns with less than 100,000 barrels daily capacity, down to and including Skelly Oil Company with 28,000 barrels reported capacity, and Barnsdall Corporation with its reported 20,000 barrels refining capacity. There are certain other organizations in the industry possessing similar refining capacities according to reports, but they are not interested in the development of hydrogenation nor do they occupy the dominant positions in the industry along other lines in addition to refining, and for these reasons were not included in an analysis having to do with hydrogenation, cracking, and industrial importance. Further, thus survey is for the primary purpose of showing those those larger companies whose total capacity aggregates 80 per cent of the refining capacity of this country by working down to the arbitrary capacity figure of 20,000 barrels daily.

Estimating roughly that these 22 companies operate their total refining capacity, which is practically 80 per cent of the total for this

country, at 75 per cent of rating, and securing 42 per cent gasoline from the barrel of crude, then this group provides the market with 76 per cent of the present daily average production of 1,250,000 barrels of gasoline. It is not improbable that these 159 refineries can actually provide retail outlets with a million barrels of gasoline each day. Estimates for the total gasoline demand for this year have been placed at 472,000,000 barrels, by H. J. Struth, Petroleum Economist for the Gulf Publishing Company publications, as published in THE OIL WEEKLY, issue of August 1, 1930, page 56. The importance of this group of companies is emphasized by the fact that they can contribute 76 per cent, or more, of this total demand.

Seven Companies; 52 Per Cent

The first group of companies in Table 1, consisting of such well known organizations as Standard Oil Company of New Jersey, Standard Oil Company of Indiana, Shell Union Oil Corporation, Standard Oil Company of New York, Standard Oil Company of California, Gulf Oil Corporation and The Texas Corporation, each with refining capacity rated above 200,000 barrels daily, operate 83 major refineries — or about one-fifth of the total in this country. It is interesting to note that Standard Oil Company of New Jersey with its three subsidiaries, has 13.92 per cent of the total refining capacity, and 16.91 per cent of the total cracking capacity of the industry in this country.

These seven companies with their aggregate rated refining capacity of 1,985,500 barrels represent 52.21 per cent of the total capacity in this country. In regard to cracking through the utilization of 1258 cracking units, these seven companies aggregate 1,033,075 barrels daily cracking capacity or 60.45 per cent of the total. All of them,

THE TEXAS CORPORATION

SUBSIDIARIES

Company—	Rated Crude Capacity Bbls. Day	Rated Cracking Capacity Bbls. Day	Number and Type of Cracking Units January 1, 1930
The Texas Company			
Port Arthur, Texas	60,000	86,000	1—Vapor Phase 52—Holmes-Manley 1—Pressure coke
Port Neches, Texas	20,000	....	
Houston, Texas	20,000	1,000	1—Tube and Tank
West Dallas, Texas	16,000	8,100	2—Holmes-Manley 3—Pressure coke
Amarillo, Texas	3,000	1,500	1—Pressure coke
San Antonio, Texas	3,000	3,000	2—Holmes-Manley
El Paso, Texas	1,500	1,500	1—Holmes-Manley
West Tulsa, Oklahoma	14,000	21,000	9—Holmes-Manley 4—Pressure coke
Lockport, Ill.	12,000	12,000	6—Holmes-Manley 2—Pressure coke
Shreveport, La.	6,500	....	
Pryse, Kentucky	2,000	2,000	1—Holmes-Manley
Casper, Wyoming	7,000	9,400	5—Holmes-Manley 1—Pressure coke
Cody, Wyoming	3,000	1,500	1—Holmes-Manley
Craig, Colo.	1,000	1,000	1—Holmes-Manley
Sunburst, Mont.	4,500	....	
Norfolk, Va.	1,500	....	
Marcus Hook, Pa.	1,500	....	
Providence, R. I.	1,500	....	
	178,000	134,100	80—Holmes-Manley, 1—V. Phase 11—Pressure C., 1—Tube and T.
The Texas Company of California			
Coalinga, Cal.	500	....	
Watson, Cal.	30,000	7,000	3—Holmes-Manley
Fillmore, Cal.	4,000	4,000	1—Cross
	34,500	11,000	1—Cross, 3—Holmes-Manley
Total—The Texas Corporation—21 plants	212,500	145,100	83—Holmes-Manley, 1—V. Phase 1—Tube and T., 11—Pressure C. 1—Cross

SINCLAIR CONSOLIDATED OIL CORPORATION

SUBSIDIARIES

Sinclair Refining Company			
East Chicago, Ill.	40,000	40,000	40—Isom
Coffeyville, Kans.	10,000	10,000	10—Isom
Kansas City, Kans.	9,000	10,000	10—Isom
Muskogee, Okla.	1,200	....	
Marcus Hook, Pa.	17,000	20,000	20—Isom
Houston, Texas	23,000	20,000	20—Isom
Wellsville, N. Y.	10,000	....	
Meraux, La. (Dismantling)	....	....	
	110,200	100,000	100—Isom
Prairie Oil & Gas Company (Producers & Refiners Corporation)			
Parco, Wyoming	8,000	3,600	6—Dubbs
West Tulsa, Okla.	6,000	3,500	5—Dubbs
Blackwell, Okla. (Shut down)	1,250	....	
	15,250	7,100	11—Dubbs
Pierce Petroleum Corporation			
Sand Springs, Okla.	8,000	4,000	4—Cross
Fort Worth, Tex. (Shut down)	8,000	....	
Texas City, Tex. (Shut down)	5,000	....	
	21,000	4,000	4—Cross
Total—Sinclair Consolidated Oil Corporation—13 plants	156,450	111,100	100—Isom, 11—Dubbs, 4—Cross

RICHFIELD OIL COMPANY OF CALIFORNIA

Richfield Oil Company of California			
Bakersfield, Cal.	2,000	....	
Fellows, Cal.	3,000	....	
Hynes, Cal.	55,000	14,000	4—Cross
Los Angeles, Cal.	4,000	....	
Watson, Cal.	65,000	16,000	12—Black
Total—Richfield—five plants	129,000	30,000	4—Cross, 12—Black

UNION OIL COMPANY OF CALIFORNIA

Union Oil Company of California			
Avila, Cal.	10,000	....	
Brea, Cal.	6,000	....	
Malta, Cal.	5,000	....	
Oleum, Cal.	30,000	....	
Santa Paula, Cal.	900	....	
Wilmington, Cal.	55,000	37,000	
Total—Union Oil Company of California—Six plants	106,$$$	37,000	7—Cross, 1—Leintz 1—Carburundum.

(Continued on next page)

ATLANTIC REFINING COMPANY

Company—	Rated Crude Capacity Bbls. Day	Rated Cracking Capacity Bbls. Day	Number and Type of Cracking Units January 1, 1930
Atlantic Refining Company			
Franklin, Pa.	9,000	6,000	6—Cross
Philadelphia, Pa.	50,000	30,000	10—Cross, 4 De Florez (bldg.)
Pittsburgh, Pa.	8,000	4,000	2—Cross
Brunswick, Ga.	5,000	3,600	2—Lewis
Total—Atlantic Refining Company—Four plants	72,000	43,600	18—Cross, 4 De Florez 2—Lewis

PURE OIL COMPANY

Pure Oil Company			
Heath, Ohio	7,500	7,500	2—Cross, 4 Gyro (2 bldg.)
Ardmore, Okla.	2,500	2,000	4—Dubbs
Muskogee, Okla.	8,000	5,500	2—Cross, 3 Gyro (1 bldg.)
Marcus Hook, Pa.	20,000	11,000	4—Cross, 3 Gyro
Nederland, Texas	30,000	20,000	24—Cross, 4 Gyro
Cabin Creek, W. Va.	3,500	1,200	3—Gyro
Total—Pure Oil Company—Six plants	71,500	47,200	32—Cross, 4 Dubbs, 17 Gyro

CITIES SERVICE COMPANY

SUBSIDIARIES

Empire Oil & Refining Company			
Cushing, Okla.	5,000	1,500	2—Doherty (shut down)
Okmulgee, Okla.	4,000	1,000	1—Doherty
Ponca City, Okla.	7,500	4,500	3—Doherty, 2 Dubbs
Gainesville, Texas	3,600	2,000	2—Dubbs
East Chicago, Ind.	15,000	9,000	6—Doherty
Cities Service Refining Company			
East Braintree, Mass.	15,000	6,300	2—Doherty, 1 Holmes-Manley
Crew Levick Company			
Pettys Island, N. J.	5,500	1,700	2—Doherty
Titusville, Pa. (bldg. add.)	6,000	.....	
Total—Cities Service Company—Eight plants	61,600	26,000	16—Doherty, 4 Dubbs 1—Holmes-Manley

CONTINENTAL OIL COMPANY

Continental Oil Company			
Florence, Colo.	3,000	1,500	8—Burton
Artesia, N. M.	1,500	....	
Farmington, N. M.	1,000	....	
Sapulpa, Okla.	4,000	3,000	6—Cross
Wichita Falls, Texas	6,000	2,000	4—Dubbs
Glenrock, Wyo.	4,000	3,000	16—Burton (shut down)
Ponca City, Okla.	27,000	16,000	6—Dubbs, 2 Cross
Baltimore, Md.	10,000	6,000	4—Dubbs, 2 Cross
Total—Continental Oil Company—Eight plants	56,500	31,500	24—Burton, 14 Dubbs, 10 Cross

SUN OIL COMPANY

Sun Oil Company			
Toledo, Ohio	12,000	10,000	2—Cross
Yale, Okla.	5,000	....	
Marcus Hook, Pa.	25,000	32,000	7—Cross, 6-own.
Total—Sun Oil Company—Three plants	42,000	42,000	9—Cross, 6-own.

STANDARD OIL COMPANY OF OHIO

Standard Oil Company of Ohio			
Cleveland, Ohio	18,000	9,600	4—Tube and Tank
Toledo, Ohio	16,000	5,400	2—Tube and Tank
Latonia Refining Co., Latonia, Ky.	8,000	2,500	1—Tube and Tank
Total—Standard Oil Company—Ohio—Three plants	42,000	17,500	7—Tube and Tank

MID-CONTINENT PETROLEUM CORPORATION

Mid-Continent Petroleum Corporation			
West Tulsa, Okla.	40,000	18,500	80—Coast (10 shut down) 4—Koontz.
Total—One plant	40,000	18,500	

LOUISIANA OIL REFINING CORPORATION

Louisiana Oil Refining Corporation			
Bossier City (No. 1)	12,000	12,500	9—Tube and Tank
Bossier City (No. 2)	3,000	....	
Gas Center	20,000	....	
Total—Louisiana Oil Refining Corporation—Three plants	35,000	12,500	9—Tube and Tank

(Continued on next page)

with the exception of Gulf Oil Corporation, are interested in the hydrogenation process and are making a study of its possibilities.

In the second grouping (capacity ranging from 100,000 barrels to 200,000 barrels) there are but four companies, including Tide Water Associated Oil Company, Sinclair Consolidated Oil Corporation, Richfield Oil Company of California and Union Oil Company of California. The four companies operate 32 refining plants, and 157 cracking units. Their total refining capacity as reported to Bureau of Mines is 549,850 barrels, and their total cracking capacity is 192,000 barrels. As a group, and in so far as aggregate capacity is concerned these four companies are comparable to the 11 companies in the third group in the tabulation. Added to the first group to make a total of 11 companies with capacity rating above 100,000 barrels daily some interesting facts are evidenced.

Eleven Companies: Two-Thirds Total

Such a group operates 115 refineries and 1415 cracking units. The total crude charging capacity as reported is 2,535,350 barrels per day, and this figure is 66.67 per cent of the total refining capacity of this country. Their aggregate rated cracking capacity is 1,225,175 barrels, which is 71.09 per cent of the country's total. It is roughly estimated that this group of 11 companies, operating at 75 per cent of rated capacity and recovering 42 per cent gasoline can provide the market with 70 per cent of the present average daily gasoline production, which is strikingly indicative of their commercial importance.

It is interesting to note that practically all of the properties or manufacturing facilities of these larger companies are in operation continuously. The exception shown in the listing of Sinclair Refining Company is brought about by that

VACUUM OIL COMPANY*

Vacuum Oil Company			
Paulsboro, N. J.	20,000	6,500	3—Cross, 3-Tube and Tank
Olean, N. Y.	6,500	1,800	2—Cross, 1-Tube and Tank
SUBSIDIARIES			
Lubrite Refining Corporation, East St. Louis, Ill.	3,500	1,700	1—Pratt, 4 Flemming
Total—Vacuum Oil Company—Three plants	30,000	9,000	5—Cross, 4-Tube and Tank 4—Flemming, 1 Pratt

SKELLY OIL COMPANY

Skelly Oil Company			1—Pipe Still
El Dorado, Kans.	23,000	15,500	12—Jenkins (6 shut down)
Pampa, Texas (announced)	5,000	....	
Total—Skelly Oil Company—Two plants	28,000	15,500	12—Jenkins, 1—Pipe Still

BARNSDALL CORPORATION

Barnsdall Corporation			
Wichita, Kans.	4,000	1,500	4—Dubbs
Barnsdall, Okla.	5,000	4,000	3—Cross
Okmulgee, Okla.	11,000	3,500	3—Cross
Total—Barnsdall Corporation—Three plants	20,000	9,000	4—Dubbs, 6 Cross

*NOTE—Since this article was written, Vacuum Oil Company has purchased the White Star Refining Company of Detroit. White Star Refining Company operates two refineries as follows: Detroit (Trenton), Michigan—crude capacity 6000 barrels, cracking capacity 5000 barrels, three Dubbs units. Wood River, Illinois, 5000 barrels crude capacity with cracking capacity of 3000 barrels, three Dubbs units. This brings the total Vacuum Oil Company crude refining capacity to 41,000 barrels, cracking capacity to 17,000 barrels, and a total of 20 cracking units. Coincident with this announcement, President C. E. Arnott on August 17 stated that negotiations should soon be completed through which a second company of similar size and operation would be acquired.

company's abandonment of its New Orleans refinery, and the acquisition of Pierce Petroleum Corporation and inclusion of Producers and Refiners Corporation, each of which have shut-down refineries. Practically all of the shut-down cracking units reported among the major companies are of the Burton type, many of which are being dismantled annually because of obsolescence and wearing out of the metal. The few other shut-down cracking units of various types are inoperative for various reasons of no interest here. The total rated shut-down cracking capacity of the group of 22 companies is 85,260 barrels, which leaves a total of 1,412,190 barrels of reported capacity in operation.

The third group of companies listed in the table consisting of 11 companies, have a total of 44 refineries with reported capacity of 498,600 barrels per day, and a total of 298 cracking units aggregating 272,300 barrels reported capacity.

The 22 major companies included in this analysis control or own 47 refining organizations, each of the integrated type, and have 159 refineries. This is 44.41 per cent of the total number of refineries operating, and 37.85 per cent of the total of 420 refineries in this country.

With an aggregate rated capacity of 3,033,950 barrels daily, as reported to the Bureau of Mines, these important companies have 83.4 per cent of the reported operating capacity in the United States, and 79.79 per cent of the total capacity, including the shut-down and building plants as of January 1, 1930.

Through the employment of 1713 cracking units, which is 85.56 per cent of all cracking units in this country, these organizations contribute largely to the present yield of gasoline from the barrel of crude, which this year has been averaging 42 per cent. Many of these companies secure percentage recoveries appreciably above the average figure, and secure gasoline yields running from 60 to 70 per cent at many of their plants. The total cracking capacity reported is 1,497,475 barrels per day, or 87.62 per cent of the total cracking capacity in the United States.

The remaining approximately 20 per cent of crude capacity and about 13 per cent of cracking capacity (289 cracking units) is divided among 241 companies with 276 refineries, as of January 1, 1930. During the past nine months about 20 new refining companies have been organized and have built or are now building plants in various sections of the country.

TABLE 2

Type and Number of Cracking Processes Used by 22 Leading Companies and Total Number of Same 29 Processes in the United States

Type Process	No. Units	Total U. S.
Black	12	12
Buerger	93	93
Burton	785	895
Carborundum	1	1
Coast	80	80
Converter	1	1
Cross	135	163
De Florez	5	5
Doherty	16	16
Dubbs	126	188
Flemming	4	8
Gyro Vapor Phase	17	17
Holmes-Manley	123	129
High Pressure	2	2
Isom	100	100
Jenkins	13	49
Koontz	4	4
Leintz	1	1
Lewis	2	4
Link	20	20
Pipe Still	1	4
Pressure Coke	11	13
Pratt	1	1
Richmond	6	6
Sun Company	6	6
True Vapor Phase	1	2
Tube and Tank	124	124
Vapor Phase	2	3
White Eagle	1	1

Total number processes in United States — 38.

Controlling the Price of Gasoline

By ALEXANDER B. MORRIS

THE season is close at hand when the demand for gasoline passes the center of its annual upward swing, and when, for five or six months use will exceed production by substantial amounts. As seems to be the customary condition, at least of late years, the price received by refiners is so close to the cost of production as to show very little if any profit, except to the largest or most favorably located operators. Some slight improvement in price has always been developed during the summer months, but there is always the very real threat that this improvement will not be sufficient to bring the year's average price above the year's average production cost.

The large potential gasoline production represented by present stocks of crude and the large cracking capacity of the country's refineries makes this threat of especial seriousness this year. Not only are crude stocks at a very high level, but crude production, already at the danger point, could easily be raised, within less than a week, to a point which would flood not only the pipe lines and refineries, but every river and stream leading out of the principal producing areas.

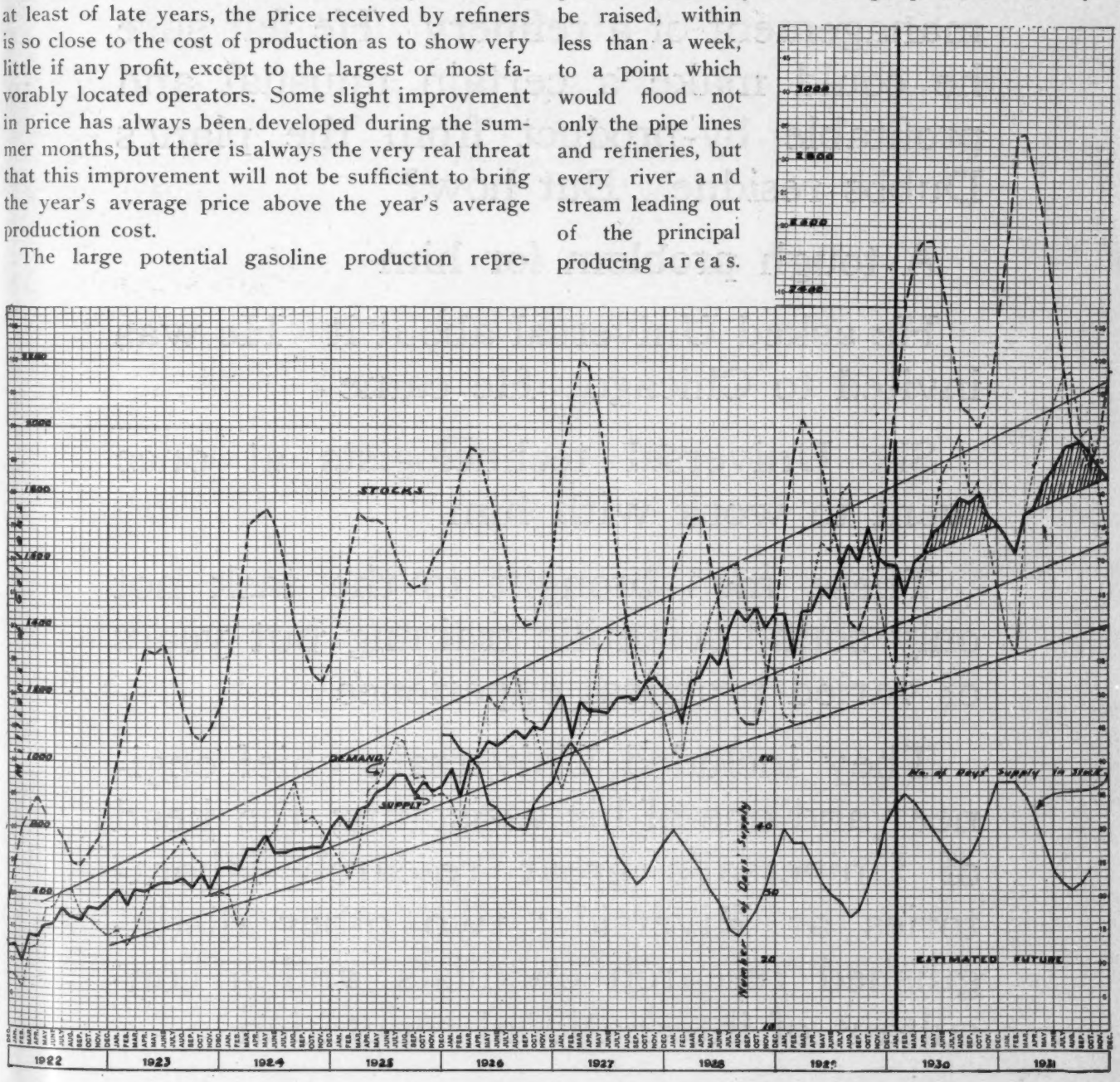


PLATE 1

Demand. Supply. Stocks in gallons and stocks in number of days' supply based on succeeding 90 days' demand from 1922 through 1931. Shaded area represents suggested curtailment of production during the next two summers

Helpfulness

An engineer, unused to Dubbs operation, recently took over the management of a refinery He felt sure he could make a certain unusual and profitable by-product from the plant's Dubbs residue But how?

A tough problem for him

He asked Universal about it He was invited to Chicago He came

Six Universal technologists at once went to work with him

These men brought to the task not only sound scientific training but years of varied practical experience

They included Universal's chief engineer and one of his assistants; the head of Universal's great research laboratories at Riverside; two other distinguished research chemists, and a consultant of international reputation

They attacked the problem from chemical and mechanical viewpoints, always with an eye to market

Result: The refiner went home loaded with facts and suggestions and confident of success

Cost to the refiner: Nothing If he should need more help, it will be as cheerfully given

All Dubbs licensees are welcome to this kind of service

Universal is always glad of a chance to help refiners make more profits

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

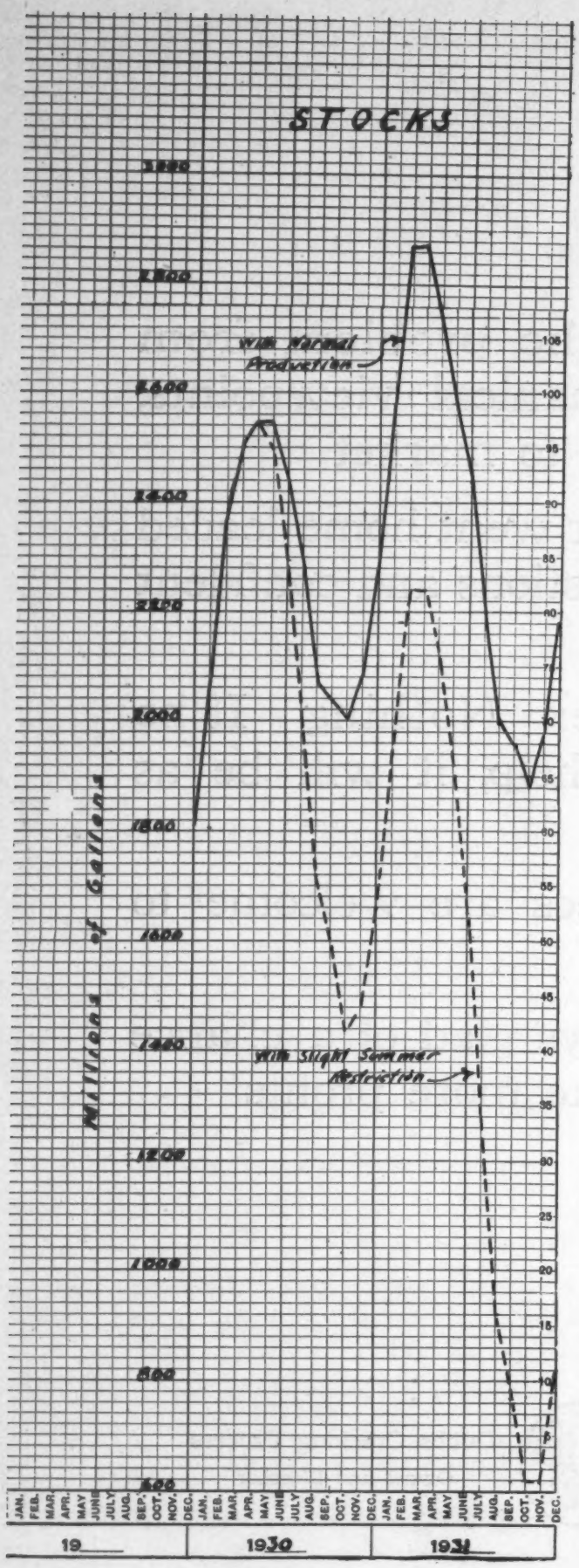


PLATE 2

Showing the effect on stocks expressed in gallons of the suggested curtailment represented by the shaded areas in Plate 1

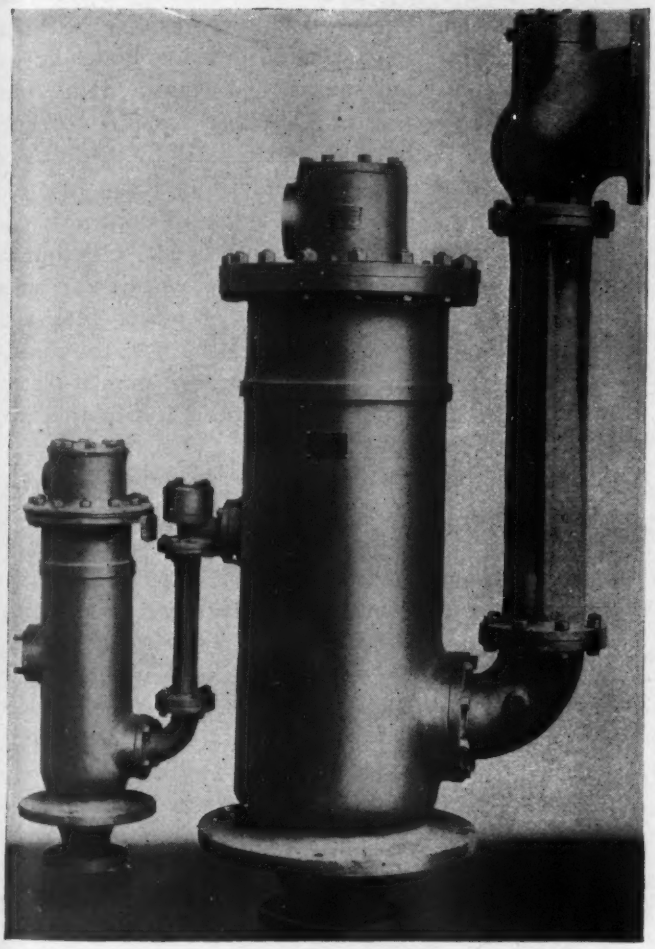
Faced with this predicament it will only be the exercise of the greatest caution that the refiners will avoid accumulation of such stocks of gasoline that complete shut down will be necessary.

Fortunately, a study of supply, demand and production over the past six or eight years furnishes a means whereby the effect of the present unregulated trend may be anticipated at the same time making possible an estimate of the benefits to be derived from any given program of curtailment. Examination Plate I will reveal a number of consistent points of control for projecting the curves at least two years into the future with reasonable accuracy. For instance, it will be observed that the peaks, the troughs and the December points on the demand curve lie very close to three straight lines for the past eight years, and that if these lines be projected through 1930 and 1931 a demand curve for those years can be constructed by sketching in a curve between the December points the February troughs and the August peaks, and the closeness of adherence of these control points to the straight line rate of increase over a relatively long period gives excellent assurance of a high probability of accuracy for the next ensuing short period. The forecast of the production for 1930 and 1931 is more open to conjecture. In this estimate the line connecting the December points on the production curve for 1928 and 1929 was projected and a production curve sketched in having the same general shape in each year that that curve assumed in the past. From these two curves of supply and demand is constructed the estimated future stocks.

The curve labelled "days' supply" is constructed from the demand and stocks curves. It represents the number of days' supply in stock at the end of each month in terms of the actual (or estimated) demand for the next succeeding 90 days. Thus the figure shown by this curve for January, 1930, is the number of days which the stocks on hand at the end of that month would last, without any additions, under the average demand conditions for February, March and April. When so constructed the days' supply curve has much more real meaning than when based on the demand for the month just past, especially in connection with a commodity whose demand changes so rapidly from month to month.

Indications are that the low point of gasoline stocks in October of the current year will be very close to the high point in March, 1929, and that the August, 1930, low point on the days' supply curve will be around 35 days instead of 27 days as for 1929 and 24 days as for 1928. These mounting stocks both in gallons and in actual days' supply are the result of an entirely unnecessary and unwarranted speeding up of refining operations during the summer months. There is no occasion for increasing production with increasing demand in a commodity of which there is already not only an

Steam-jet Air Ejectors



for the

Oil

Industry

PIONEERED by Westinghouse, leading manufacturer of air removal apparatus, steam-jet air ejectors have been developed to a high degree of efficiency, simplicity and reliability, over a wide range of application. The outstanding performance of this equipment with all types of high-vacuum condensers has definitely established its superiority to that of any other type of air-removal apparatus.

Each application of this equipment for any specific condition is an individual engineering problem for which Westinghouse maintains a staff of competent engineers. An inquiry at our nearest office will bring this service to you.

Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

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actual surplus but a potential surplus far in excess of any possible use which is readily realizable within a fraction of the time that the present stocks will last.

If the humps in the supply curve could be levelled off during the next two summers, and the production of gasoline gradually increased throughout the period somewhat as indicated by the lower edges of the shaded portions, very decided benefits would result. Of course much greater benefits would result from a complete flattening of the supply curve, but that is useless even to think of. There seems to be little reason, at least none apparent, why the rate of increase in rate of production of this already too plentiful product should not be more gradual. As a whole refineries can operate efficiently at 80 per cent capacity, and if, in doing so, they are already making more gasoline than is to be used, why assure the absence of profits on all the summer's output by speeding up to 100 per cent capacity the moment the increase in seasonal demand gives promise of affording some relief?

The effect of this suggested curtailment is shown in Plates 2 and 3, the October, 1930, trough of the stock curve is lowered to 1,440,000 gallons, well below the 1929 peak and only slightly above the 1929 trough. The saving effect of this course on the situation in 1931 is even more marked. In fact were even this moderate program of curtailment adhered to by the country's refiners, the stocks of manufactured gasoline held at refineries would be reduced to about 600,000,000 gallons by October, 1931, a point which would be equivalent to but 11 days' supply.

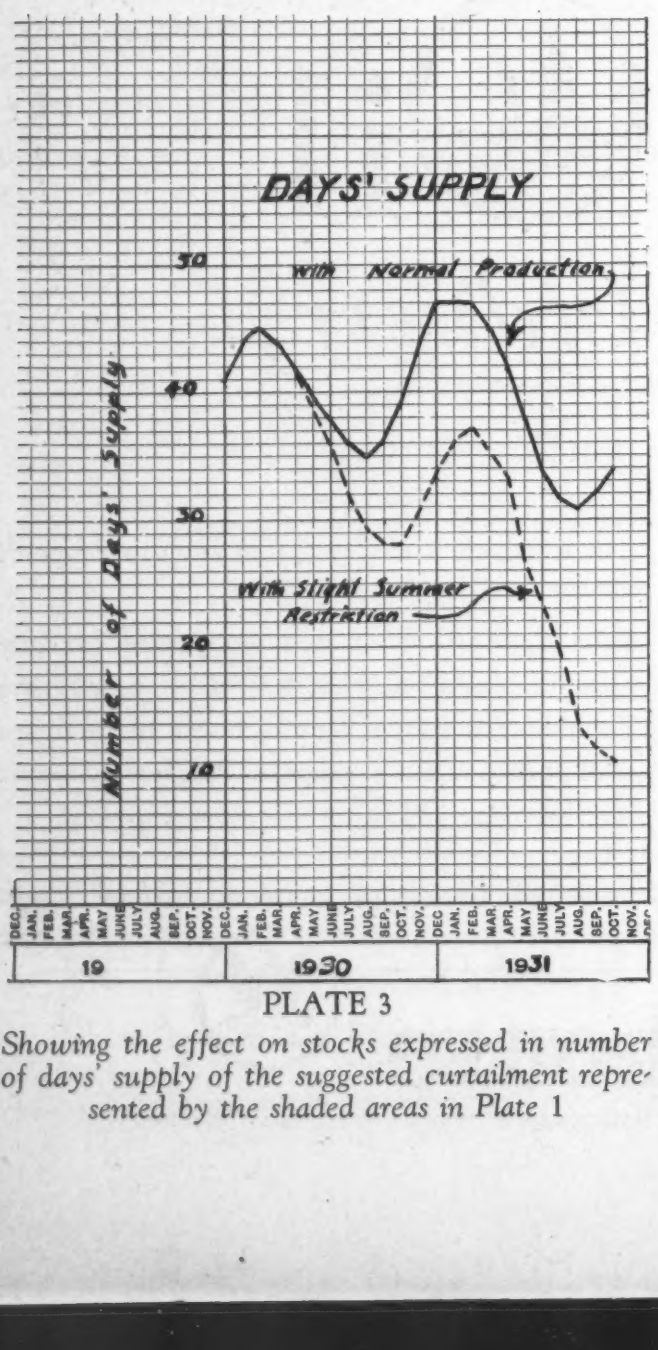

DAYS' SUPPLY
With Normal Production
With Slight Summer Restriction
Number of Days' Supply
30
40
30
20
10
DEC. JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEP. OCT. NOV. DEC JAN. FEB MAR APR. MAY JUNE JULY AUG. SEP. OCT. NOV.
19
1930
1931

PLATE 3

Showing the effect on stocks expressed in number of days' supply of the suggested curtailment represented by the shaded areas in Plate 1

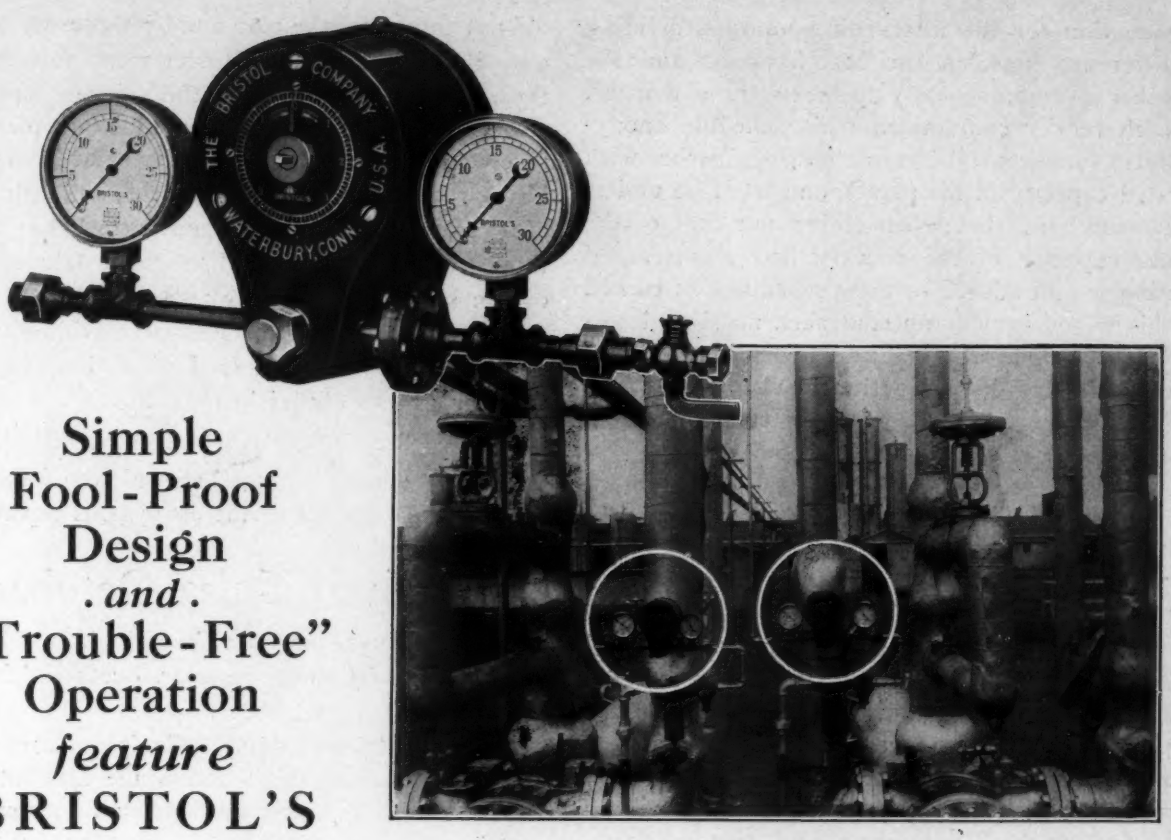
Were there not on hand such large stocks of crude oil, and were it not possible within a very short time greatly to increase the output of gasoline without loss of time in extensive additions to plant, such a low supply on hand might represent a dangerous condition. However, in October, and for several months thereafter normal demand will be below even the normal minimum of production. Runs to stills can be increased over night and any danger of an actual shortage immediately removed. Of course, competitive conditions would never permit any such depletion of the nation's stocks of motor fuel, and even with the closest control and the best intentions to adhere to some such program, many plants would exceed their quotas of production in the face of such rapidly falling stocks.

The main purpose of this article, however, is to show what surprisingly strong influence upon gasoline stocks can be worked by a little moderation in summer production for as short a period as two years. The program suggested does not involve any reduction of output—merely a restraint upon the tendency to make production catch up with demand at a time when demand, in the rear for the greater part of the year, has its only natural opportunity to catch up with production.

The question of price has been carefully avoided so far in this discussion. Any attempt to forecast gasoline prices even for one month ahead is futile. It is certain, however, that the reduction of gasoline stocks to a point where they represented only 11 or even 20 days' supply, would not cause any price recessions. Let us assume then that this program would have no effect upon gasoline prices whatever; that the ocean of crude in storage and the ready convertability of this into gasoline tended to prevent any appreciable rise. Even thus, the refiners would benefit materially from an operating policy which permitted them to store their gasoline as crude rather than as a finished product. Not only are the storage losses from crude storage less in actual volume, but such losses entail no losses of refining labor and overhead such as are involved in storage losses of finished gasoline.

SCHEDULE PRODUCTION

As a means toward accomplishing this very desireable end, let every refiner estimate what will be his normal gasoline output next December, and starting with his March output make out a schedule



Simple Fool-Proof Design *. and .* "Trouble-Free" Operation *feature* BRISTOL'S

Air Operated Control Equipment!

ABOVE are shown two Bristol's Air Operated Temperature Controllers installed at one of the larger Natural Gasoline plants in the Greater Seminole Area of the Mid-Continent field. These particular instruments are used to automatically control pre-heater temperatures, thus insuring a constant temperature of gasoline entering the stabilizer column.

This type of Bristol's Control has been thoroughly proven in service . . . many successful installations have been in operation in all branches of industry for several years.

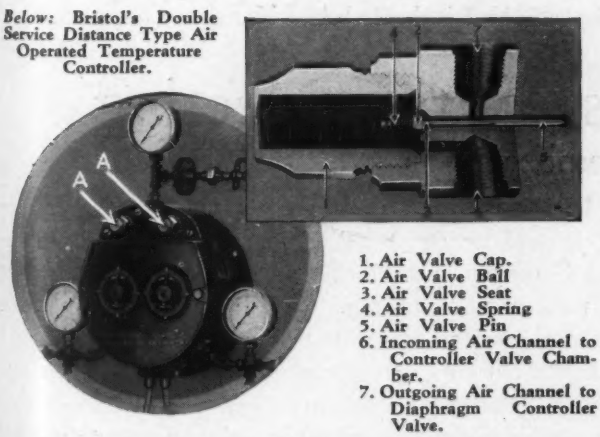
Those responsible for instrument operation and maintenance will immediately appreciate the rugged, durable construction, and simple design of all operating parts in this Bristol's Controller. Especially as such design pertains to the controller air valve (see detailed descriptions elsewhere on this page).

Complete control equipment can be furnished to automatically regulate either temperature or pressure . . . temperatures up to 550° Fahr., or pressure to 500 lbs. per square inch.

Complete information, prices, etc., will be sent to any interested person in your plant. Get in touch with nearest Bristol's Branch Office or write direct to home office at Waterbury, Connecticut.

Sectional view shows simple trouble-free design of Air Valve in Bristol's Controllers

Below: Bristol's Double Service Distance Type Air Operated Temperature Controller.



1. Air Valve Cap.
2. Air Valve Ball
3. Air Valve Seat
4. Air Valve Spring
5. Air Valve Pin
6. Incoming Air Channel to Controller Valve Chamber.
7. Outgoing Air Channel to Diaphragm Controller Valve.

A distinctive feature which has done much to establish the fine record of Bristol's Air Operated Controllers is the simple design, rugged construction and accessibility of the Controller Air Valve. As shown above at (AA), the Controller Air Valve Cap extends thru front of instrument case; readily accessible for inspection, cleaning, replacement or interchanging.

To remove, unscrew air valve cap (A or A) and lift out air valve (2) with spring (4) attached. The Valve seat (3) is then exposed, almost flush with front of instrument case.

To replace, simply screw Valve Cap (1) into position again. The Controller is immediately ready to operate—no further adjustments are necessary. In fact, no adjustment is required regardless of length of time instrument remains in service.

[*Field Engineering Service without obligation*]

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BRISTOL'S

of production for the intervening months, dividing the difference between the March actual and the December estimate equally between these months. Let each refiner communicate his schedule anonymously to some central clearing house, together with the rated capacity of his plants, and let it be understood beforehand that when eighty per cent of the refining capacity of the country had reported, all reporting would adhere to their schedules as turned in. This would involve no contracts, no signed correspondence, no legal obligation to keep any prearranged faith. No discrimination would be practiced as all refiners would be advised of the reports received whether they reported themselves or not. There would be some backsliding, without a doubt. There would be some plant expansions by those who did not come into the plan and by those who dropped out of it. No scheme will ever work perfectly. But those who stuck, provided the spirit to stick was strongly upon those who entered into the plan, would receive all the benefits in capacity sales from storage, heavy reductions of finished stocks, and reduced cost of operations over the summer months; whereas those who dropped out and sought to take advantage of the situation created by the steadfastness f the others would find themselves next winter with undiminished stocks, increased plant investment and summer profits diminished by the added operating costs of their enlarged plants run to capacity.

Will not some disinterested soul step forward and volunteer as compiler of the ananymous reports?

Refining Papers on A. S. M. E. Program at Tulsa, October 8

THE refining division of the petroleum industry, and the pipe line phase of the oil producing industry are featured in the program arranged by the American Society of Mechanical Engineers at its meeting at Tulsa, October 6 to 8, during the International Petroleum Exposition. National President Charles Piez will be present and speak. The program as it pertains to refining, follow:

"Improving Combustion Efficiency in Oil Refineries," by J. R. Darnell, Hyde Park, Boston, Massachusetts.

"Cotrell Process for Sulphuric Acid Recovery," by P. E. Landlot, Western Precipitation Company.

"Creep Stresses in Various Alloys at Elevated Temperatures," by R. L. Duff, Standard Oil Development Company.

"The Hot Oil Pump for Cracking Stills," by J. M. Shimer, Wilson-Snyder Pump Company.

"The Hot Reciprocating Pumps for Cracking Stills," by F. B. Applegate, Worthington Pump Company.

"The Refinery-Automatic Control of Each Process," by M. J. Bradley, chief engineer, Leeds and Northrup Company.

"Design of Heat Exchange Equipment for a Single Flash Fractionating Unit for Crude Distillation," by D. B. Irwin, Pan American Petroleum Corporation.

"High Pressure, High Temperature, Pipe Still Refining Equipment and Process," by John Primrose, Foster-Wheeler Corporation.

"Cracking Equipment," by Lyman C. Huff, chief engineer, Universal Oil Products Company.

"Stabilization and Absorption, Technical and Economic Considerations," by L. S. Gregory, Whealton and Townsend Company.

"Heat Losses in Refining," by H. S. Bell, consulting petroleum engineer, New York City.

"Insulation of Cracking Coil and Tube Still Furnaces," E. V. Rinehart, Johns-Manville Corporation.

National Petroleum Association Meeting

Atlantic City, September 17-19

NATIONAL Petroleum Association will hold its annual convention at Hotel Traymore, Atlantic City, New Jersey, September 17, 18 and 19. The program at this meeting embraces the interesting topics of hydrogenation, aviation, marketing of petroleum products and petroleum economics.

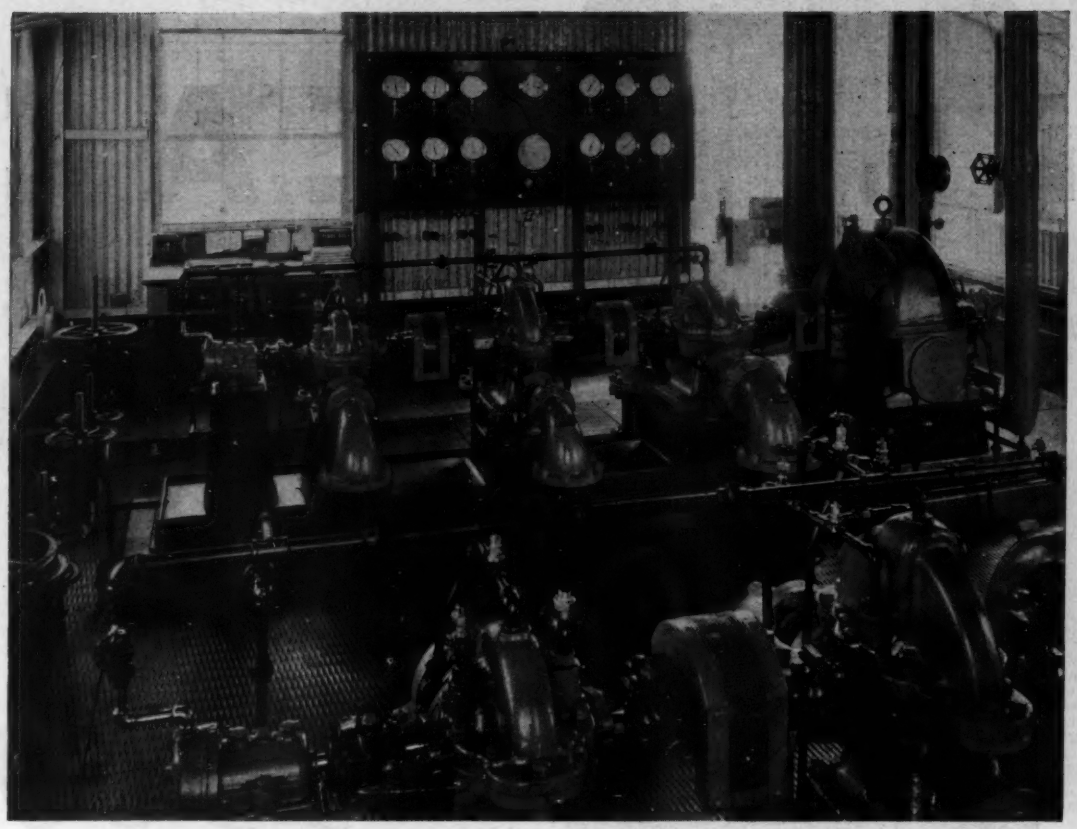
Colonel Clarence M. Young, assistant Secretary of Commerce, in charge of aviation will speak on the relation of the Federal government to the development and control of aviation. Guy W. Vaughn, president, Wright Aeronautical Corporation will discuss the problems and needs of the airplane manufacturer. L. D. Seymour, National Air Transport Company will speak of the problems of airplane manufacturers.

From a manufacturing standpoint, one of the most interesting and important developments in refining is the Hydrogenation process and the story of the system will be told by Dr. R. T. Haslam, Standard Development Company. Dr. Haslam is also presenting a paper on this process at the meeting of the American Chemical Society, early in September.

H. L. Horning, president, Waukesha Motor Company, will discuss cooperation between the automotive and petroleum industries. Economics of the petroleum industry will be presented by one of the members of the Federal Oil Board's economic committee. R. B. Kahle, president, Colonial Beacon Oil Company will discuss some of the problems of marketing.

The annual banquet will be held September 18 and on the same day the members will be entertained at luncheon by Sinclair Refining Company at the Sea View Golf Club prior to the annual golf tournament.

TERRY



EFFICIENT TURBINE DRIVEN UNITS FOR THE GASOLINE PLANT

Illustrated above is a 133 HP Terry Turbine installed in a gasoline plant of a Western oil company.

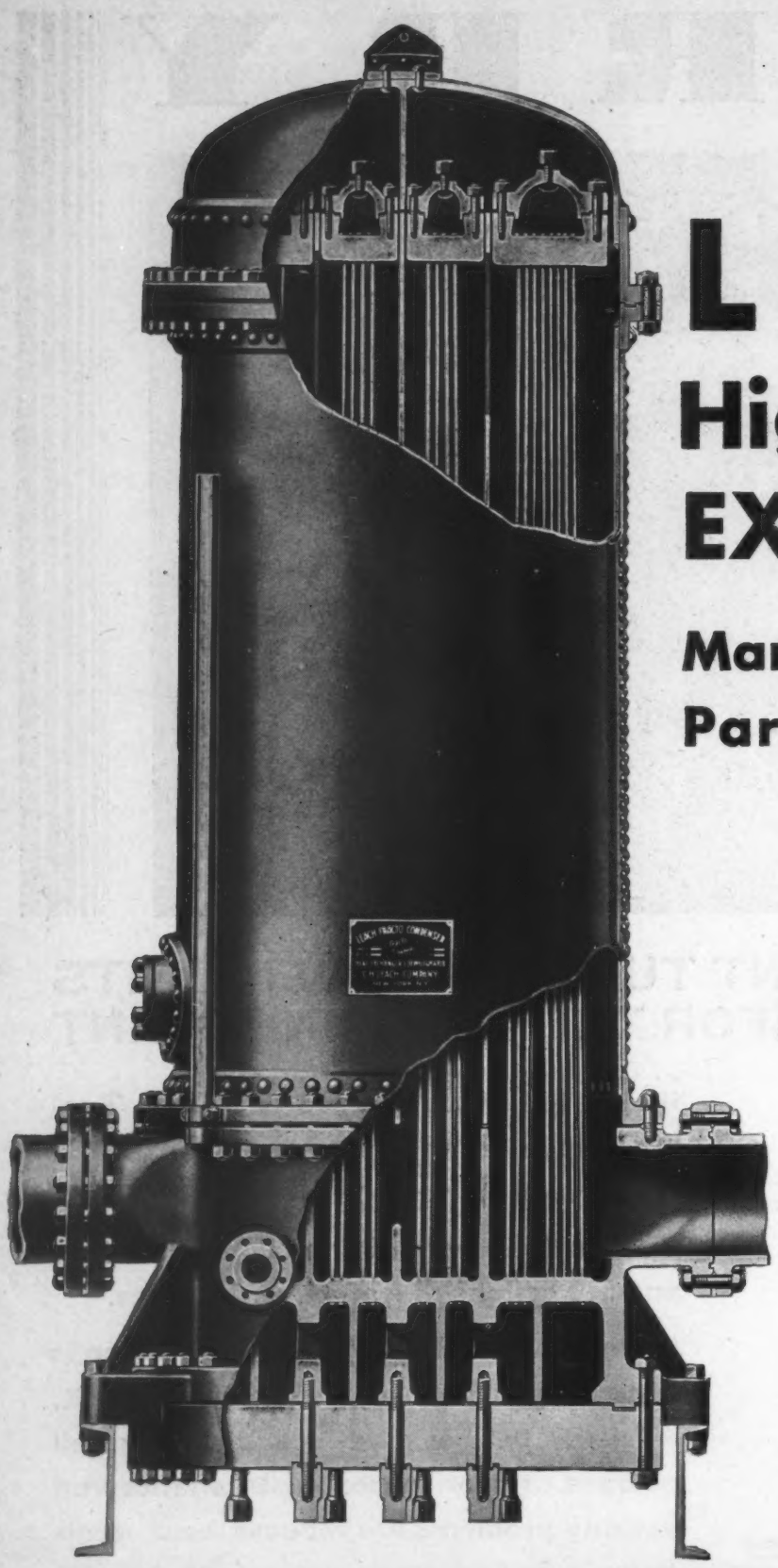
The unit delivers 1800 gallons of water and 550 gallons of lean oil per minute.

A well balanced flow of oil and water is assured at all times. The unit is compact, efficient, flexible and occupies a small amount of floor space. Maintenance and packing problems are reduced to a minimum.

Full information on Terry turbines for pump drive or any other application furnished on request.

The TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.
Steam Turbines - Gears - Shaft Couplings

T-1068



LEACH
High Pressure EXCHANGERS
Manufactured of Parts Tested at
5300
lbs. per sq. in.

The Leach Fracto Condenser is fully protected by patents in the United States and foreign countries.

LEACH Fracto Control TRADE MARK REG.

Stabilizing Unit Handles 290,000 Gallons Daily

A SINGLE stabilizing unit which is successfully handling up to 290,000 gallons of gasoline daily has been completed by General Petroleum Corporation at its Santa Fe Springs absorption plant, the installation ranking as one of the outstanding developments of the year in gasoline plant construction.

Regarded for some time as the largest natural gasoline plant in the world, the addition of a more modern stabilizing installation has increased the efficiency of operation and made possible the manufacture of a specification product under all conditions.

Gas treated at Santa Fe Springs comes from several zones, and while each sand yields a slightly different gas, the gasoline obtained does not vary as might be suspected. Pressures also vary in the different zones, but these conditions pertain more to the main absorption plant than to the stabilizing unit.

The main stabilizing column is five feet in diameter and 85 feet high. It is equipped with 36 trays and designed for a working pressure of 200 pounds, although it is now operating at an average pressure of 195 pounds. Originally designed to handle from 150,000 to 170,000 gallons of gasoline daily, the column is successfully carrying about 80 per cent more and probably could handle a full 100 per cent overload.

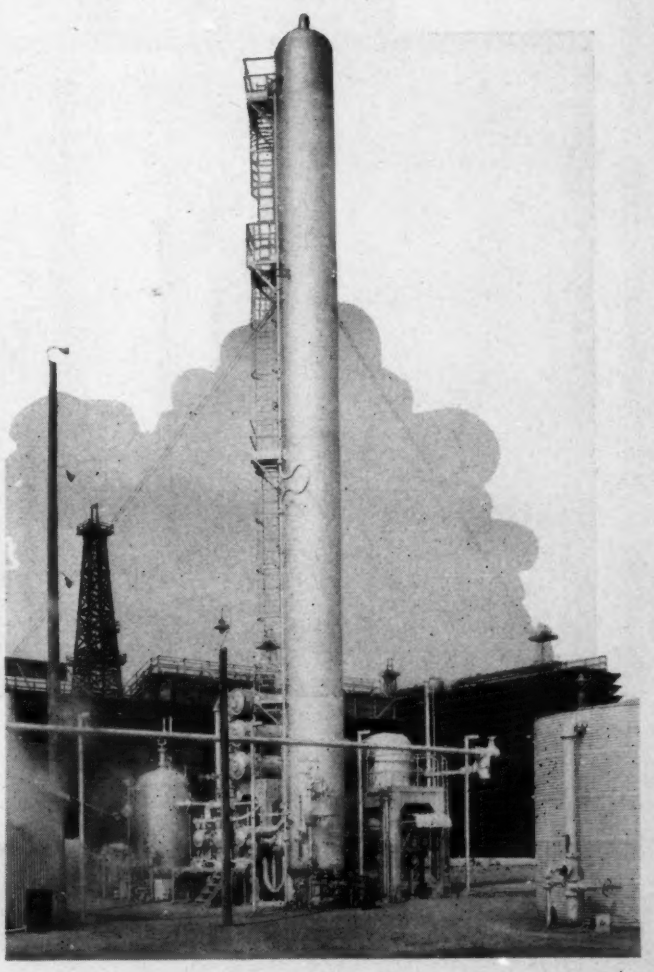
Six 15-inch by 13-foot, Type F-155 heat exchangers are used, arranged in two rows of three each near the base of the installation. Three 26-inch by 10-foot, Type K-120 condensers are arranged, one over the other, beginning just above the heat exchangers. The re-boiler is 48 inches by 80 inches and stands near the base of the main column. The accumulator is General Petroleum Corporation's own design. The principal working parts are compactly arranged, the company's engineers having helped to achieve this. Auxiliary equipment, including pumps and meters, is located near the base of the main tower.

Raw gasoline from the five absorption units is pumped directly to one large accumulator tank under a pressure of 40 pounds, this pressure also being held on the tank. From this point it is picked up by centrifugal pumps and sent through three exchangers and one preheater and into the main column at a pressure of 250 pounds at the pump and a temperature of 245°F. Gasoline from the column enters the re-boiler at the bottom, passes out of the top and returns to the column at a point about 12 feet above the base. Gasoline leaving bottom of the main column passes through three heat exchangers and two coolers and to storage tanks.

Vapors passing off the top of the column are partially condensed by three condensers, the condensate running into a reflux accumulator and the uncondensed vapors passing out of the top of the same through a back pressure regulator.

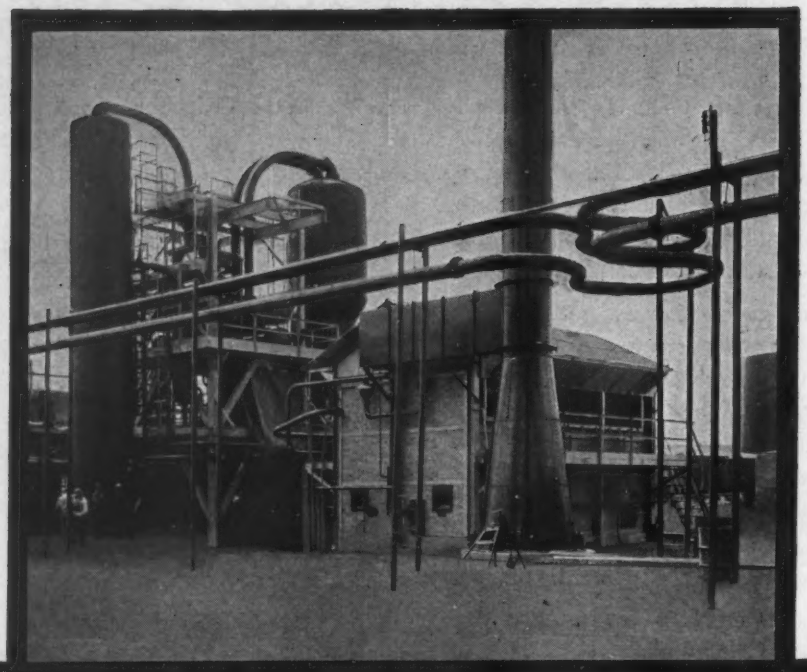
A part of the reflux is pumped from the accumulator to the top of the column to maintain the desired temperature at that point. The excess reflux from the accumulator is expanded through a heater to the fuel line.

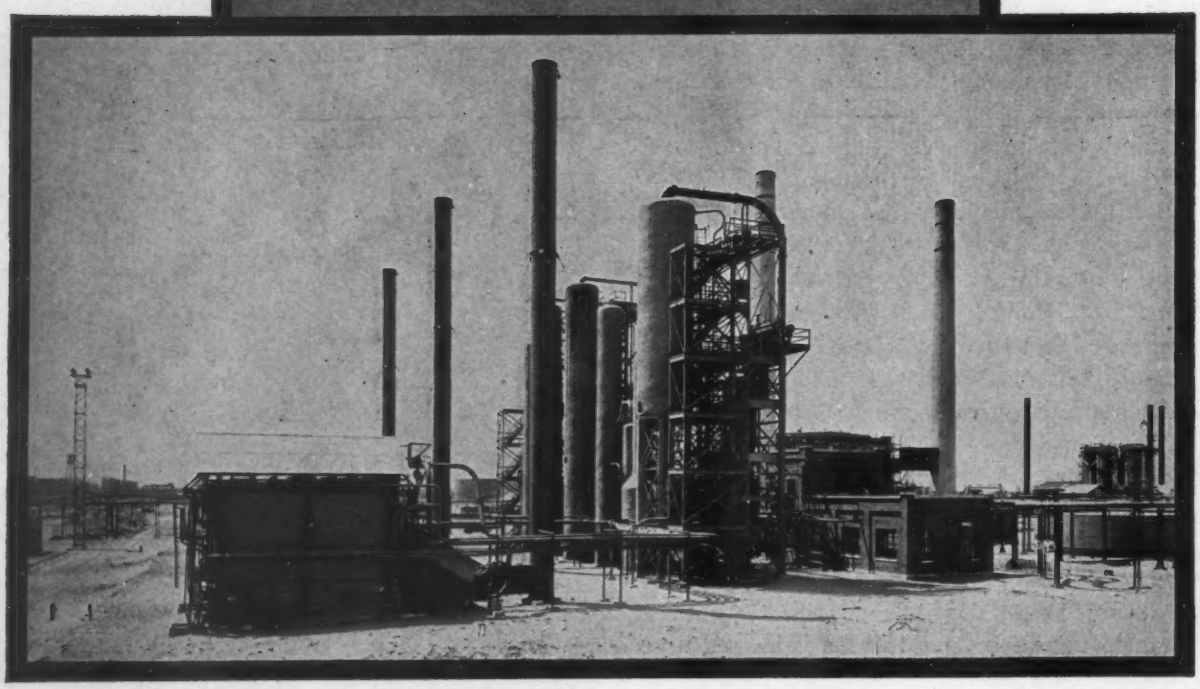
Care is taken to maintain a constant gasoline feed and reflux rate, to insure even quality of gasoline and



Stabilizing unit at General Petroleum Corporation's Santa Fe Springs, California, plant

PROGRESS



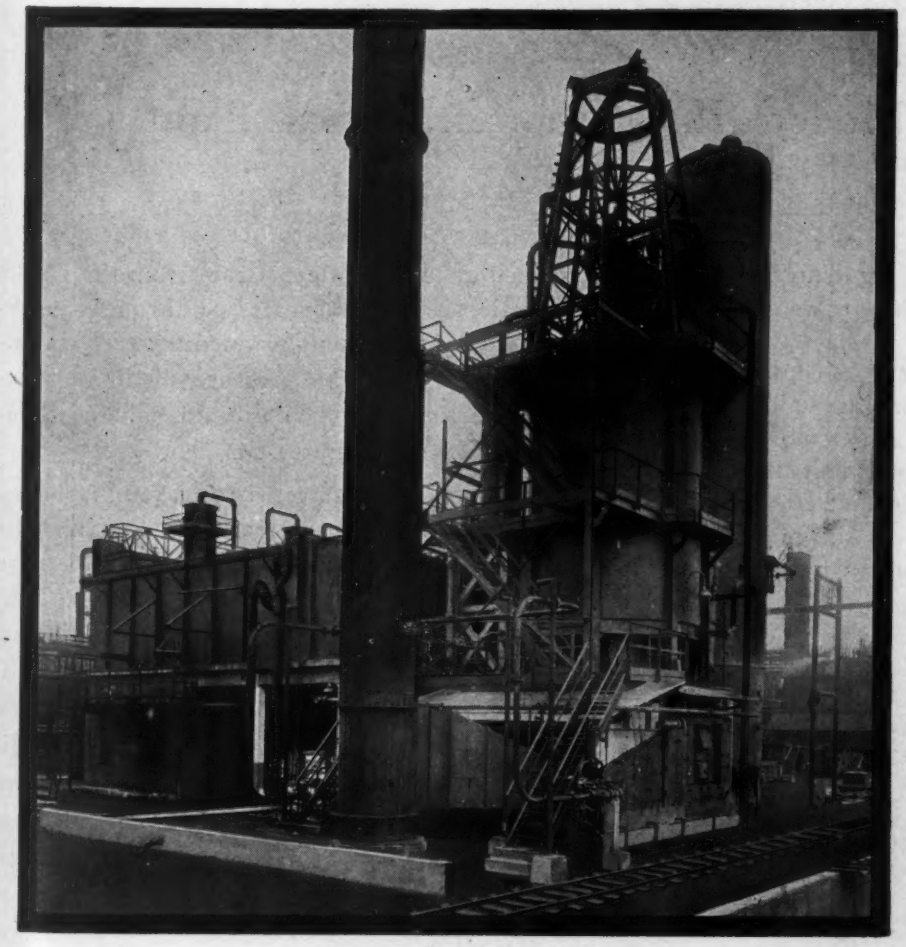


E. B. BADGER &

NEW YORK LOS ANGELES

E. B. Badger & Sons Company has been and is the leader in the development and successful commercial application of most of the present day types of complete refining units.

Continuous improvement is essential to meet changing conditions and requirements. We are carrying on constant and extensive research and experimental work.



The following Companies are some of those who have purchased BADGER Equipment:

The Texas Company
Tide Water Oil Co.
Sinclair Refining Co.
Anglo-Persian Oil Co. Ltd.
Emlenton Refining Co.
Shell Petroleum Corp.
Phillips Petroleum Co.
Standard Oil Co. of N. J.
Empire Oil & Refining Co.
Texas Pacific Coal & Oil Co.
Associated Oil Co.
Pennzoil Company
Independent Refining Co.
Gulf Refining Co.
Tidal Refining Co.
Continental Oil Co.
Anglo-Mexican Petroleum Co. Ltd.
Cities Service Refining Co.
Barnsdall Corporation
Beacon Oil Company
Pierce Petroleum Corp.
Magnolia Petroleum Co. of Texas
New Orleans Refining Co.
Skelly Oil Co.
General Petsoleum Corp.
Shell Oil Company
Freedom Oil Works Co.
Vacuum Oil Company
Richfield Oil Co.
Humble Oil & Refining Co.

SONS COMPANY

TULSA HOUSTON BOSTON

to guard against loss of desirable fractions. Both the raw gasoline and reflux feeds is regulated by Foxboro controllers, the usual orifice arrangement being maintained.

The re-boiler and column temperatures are maintained within one-half of one degree of the desired temperature, the success of the stabilization depending largely upon this small deviation from the ideal temperature. The pressure on the stabilizing column is maintained within one-half pound of the desired pressure.

The regulator is on the water condensate from the re-boiler. Boiler pressure is maintained on the re-boiler, while the desired temperature is maintained by a half-inch regulator installed on the water condensate leaving the re-boiler. When the valve is closed, water covers the tube section, and when the valve is opened, water leaves the tower, allowing steam to cover the tube section and thereby increasing the temperature.

Liberal use of concrete for supporting such equipment as the heat exchangers and condensers add strength to the installation and reduces the fire hazard. Elimination of buckling from steel platforms is also accomplished, in addition to a more attractive appearance. The ladder leading up the main column is enclosed by a barrel of heavy wire netting—an added safety factor for workmen.

Five large DeLaval centrifugal pumps are used for circulating water and moving the gasoline, two being for the former and three for the latter. All pumps are in a pit below the surface of the ground. The pump house is equipped with blowers to prevent accumulation of dangerous fumes.

The unit was designed and built by C. F. Braun and Company; actual arrangement of the equipment being largely in the hands of company engineers. Besides handling an almost unprecedented gallonage, the unit is one of the most attractive installations yet completed.

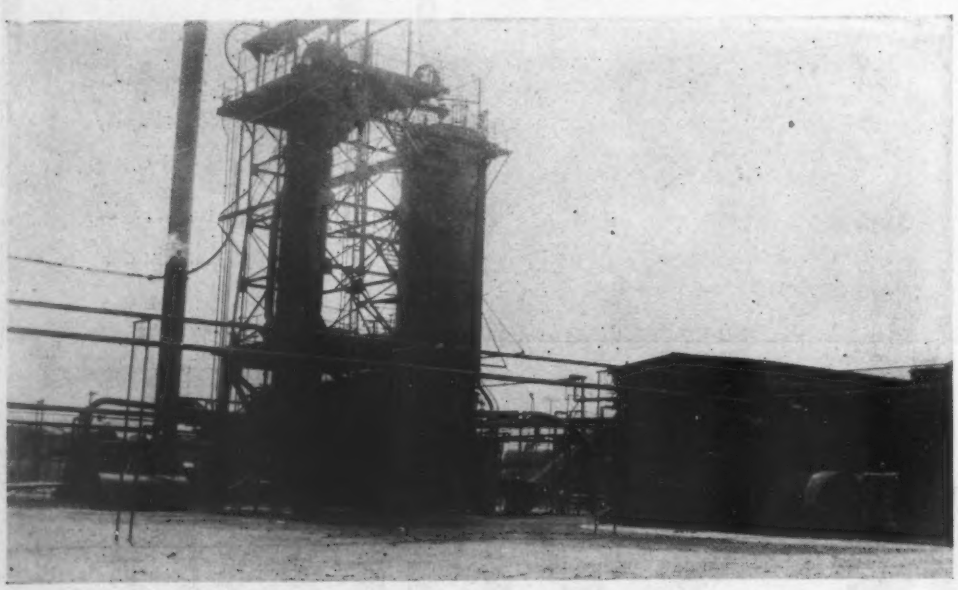
Wilcox Has Modern Installation in Bristow Plant

(*Continued from page 74*)

treating systems are provided for handling the light products, and agitators of the batch type were erected for kerosene treatment.

A recent addition at this plant is a compression type gasoline recovery installation for which gases and vapors are gathered from the skimming plant receiving house, the redistillation plant receiving house, light product storage and crude tanks. Yields from these vapors run from two to six gallons per 1000 cubic feet. The plant production ranges from 4000 to 5000 gallons per day. Gases from the Dubbs unit operation are to be processed through an absorption type recovery unit planned for early installation. Vapors from the pressure distillate rerun operation are first scrubbed through alkaline solution before they are compressed.

The compression plant consists of four 80-horsepower Bessemer machines operating at 40 pounds on the low stage side and 175 pounds on the high stage side.



Cracking equipment at Wilcox Oil & Gas Company's Bristow, Oklahoma, refinery

Early in the construction of the new refinery P. I. Tinkler joined the organization as construction engineer. He supervised the installation and design of facilities, and upon completion of the plant was made superintendent of its operation, and has directed the modifications and additions to the plant as discussed in this writing. We are indebted to Mr. Tinkler for his helpfulness and his permission to present the details of plant operations.

You're *Free* from "cold-junction" errors

With POTENTIOMETER PYROMETERS

Actual chart width is 9⅞ inches

BECAUSE of the electrical principle* upon which it is built, the L & N Potentiometer Pyrometer offers the simplest and most reliable automatic compensation for "cold-junction" temperature changes. A small spool of nickel wire, mounted on the terminal panel, varies in resistance with changes in temperature at the instrument.

Positive, mathematically accurate and free from moving parts, it provides absolute protection against cold-junction errors.

The greater accuracy and complete reliability of L & N Potentiometer Pyrometers is leading thousands of plants to better results in heat-treating processes.

L & N Catalog 84-R lists L & N Potentiometer Pyrometers for automatic temperature control. Catalog 87-R lists them for recording and for indicating. Special bulletins outline their application to various industries

** Information as to the outstanding advantages of the L & N Potentiometer system of temperature measurement will be supplied on request.*

LEEDS & NORTHRUP COMPANY
4901 STENTON AVENUE PHILADELPHIA, PA.

LEEDS & NORTHRUP

P-208 **Cleveland Chicago Houston Los Angeles San Francisco**

L&N Potentiometer Pyrometers—Different From All Others—Most Accurate In Industry

For Indicating, for Recording, and for Automatically Controlling Temperatures

Empire Plant Operators Have Study Club at Seminole

IT started as a conference of four men employed at Empire Oil & Refining Company's Lacy natural gasoline plant near Seminole. Now there is an organization which may be styled the Study Club of Empire Natural Gasoline Plants of the Greater Seminole Area. If such a title is a bit staggering by its length it can be stated now that the larger organization is but the machinery through which natural gasoline plant operation is being bettered in this district.

The four men met informally in the Lacy plant office to discuss the problems of their work and to devise methods of overcoming their difficulties. These meetings took place at night, often three and four times a week. Shortly they became a custom and it was decided to enlarge the gathering to include other men of the Lacy plant. The four wanted to put themselves in position to direct the work of calling the whole plant staff into the scheme.

Where Empire meets to solve plant problems

Just how these conferences grew into a district proposition is something neither C. F. Fischer, Lacy plant superintendent, R. H. Hunter, R. L. Poteet nor W. P. Southard knows. They are the four who composed the quartet of the early meetings. Perhaps J. W. Wilson, district superintendent, told the men at the other Empire plants. At any rate men from these plants were shortly asking to come over and sit in at the Lacy plant conferences. Soon the number taxed the plant office space, which may account for an addition to the building.

By May 7, 1930, the larger organization had been formed, a set of officials had been selected, a program committee named and arrangements made to meet once a week. By that time a place for the meetings had become a problem so some flood lights were erected and the meetings moved outdoors. That had its difficulties so the study was given up for the summer and October 1 selected as the date for resumption of programs. By that time some suitable quarters will have been provided.

Officials are elected each two months. The first list of officials consisted of E. R. Estus, superintendent of the Jones plant, president; L. A. Sperry, superintendent of the Asher plant, vice-president; C. F. Fisher, superintendent of the Lacy plant, secretary. Each election will bring one new official into the list. A secretary is elected each time and the two officials above him are pushed upward, while the president leaves office. R. H. Hunter, stock foreman of the Lacy plant is now secretary, this leaves Mr. Sperry president, and Mr. Fischer, vice-president.

J. W. Wilson, district superintendent of Empire natural gasoline plants in the territory was named chairman of the program committee and continues to hold the position. His duties are to select the subjects for discussion and to name the men to present them.

A typical program is one on specifications of natural gasolines. With a subject like that the whole club membership gets into the discussion, after the subject has been presented.

Programs are kept within the range of subjects common to natural gasoline plant operation. Frequently one meeting does not give sufficient time to complete discussion. Then the subject is carried over another week so the membership can have full opportunity to give individual opinions.

Membership is limited to superintendents, assistant superintendents, testers and stock foremen. There are 17 men in the Seminole area eligible to membership and all belong. The Lacy plant has five; Jones plant, three; Konawa plant, three; Asher plant, three; Maud plant, one; and Wilson plant, two.

No dues are required. During the summer once a month a picnic or some other event takes the place of a program. For such events club members are assessed to defray expenses.

"Here, Lad—

I believe you're nearly right on the fact that the 'Linc-Weld' motor is breaking a lot of records on performance—but remember, we can't immediately change to 'Linc-Welds' without breaking a lot of restrictions surrounding our buying."

"Sure, Pop—

Which in turn imposes restrictions on our earnings.

Economies offered us by the 'Linc-Weld' motor due to modern STEEL construction—larger bearings and shafts—greater overload capacity—are REAL economies.

Our restrictions are old-time *fancies*.

If in order to get out of our motor groove we have to smash some of the restrictions around free business conduct—let's smash them. There'll be plenty left.

I was just reading where more than 2000 new laws have been passed in this country in three years. No doubt this contains generous allowance for breakage."

"Linc-Weld" Superiority is due to:

1. Larger Shafts
2. Larger Bearings
3. Better Insulation
4. Stronger Frame (Steel)
5. Greater Overload Capacity

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LINCOLN
"LINC-WELD" MOTORS

The Hydrogenation of Mineral Oils

(*Continued from page 71*)

would analyse as high perhaps as 16 per cent of hydrogen, a good high vapor-phase gasoline 12 to 13 per cent. There is only a difference of 4.6 pounds of hydrogen per 100 between Trinidad asphalt and pure Octane, C_8H_{18}. This would amount to about 14 pounds per barrel, if it were possible to get such combination by direct addition. For the average Mid-Continent residuums from three to six pounds per barrel would be the range if a gasoline comparable to straight run were the objective. Naturally such would not be the objective as such motor fuel would not possess the desirable antiknock properties of the naphthene, aromatic and hydroaromatic mixtures. By utilization of the hydrogen, free and combined of the fixed gases from hydrogenesis equilibrium the additional hydrogen supply per day for a 1000-barrel per day plant should not exceed 1,000,000 cubic feet, which is approximately 5600 pounds.

COKE OR CARBON RESIDUE

In destructive distillation of crude oils a coke or carbon residue remains in the still. The amount of this residue is dependent upon the temperature and pressure conditions for a given crude and also to a degree by the type of apparatus employed. Distilling under vacuum certain crudes may distill over without deposition of residue, asphaltic crudes leave a residue on vacuum distillation. The minimum change in the chemical nature of the distillation as compared with the original change takes place at the lowest pressure. With increase of pressure these changes become greater more residue is left in the flash after the distillation is complete. As higher pressures are carried, the temperature required to effect vaporization increases until finally a stage is reached where the heavier higher boiling hydrocarbons cannot withstand the additional energy input required for vaporization therefore the molecules suffer chemical change into simpler and more stable forms capable of vaporization or capable of withstanding additional heat absorption in the liquid phase. Naturally the liquid phase heat stable hydrocarbons are those with the greatest ratio of carbon to hydrogen as it may be stated that without exception for hydrocarbons that those compounds having the greatest per cent of carbon to hydrogen for a given number of carbon atoms have the greatest heat capacities in the liquid state. More heat is required per pound mol to effect vaporization. This too is of note that the chemical activity and power for combination increases with a decreasing percentage of hydrogen per pound mol and until that stage of hydrogen carbon complex is reached where the characteristics are more carbon, then hydrocarbon. Polymerization and condensation occur in an increasing degree until such a stage is reached that further heat energy input can only react towards separation into the elements of carbon and hydrogen.

The question here that naturally arises is: what changes would have occurred in a pressure system for destructive distillation of hydrocarbons such as crude residuums had hydrogen been admitted during the operation? This can be answered if the nature of the original charge is known together with the operating temperature, pressure and time, catalysts if any, and effectiveness of contact with hydrogen, also the amount of hydrogen. At 200 atmospheres and 785° F. with slow distillation there would be little carbon residue if the hydrogen were well distributed and there was no hot-spotting of the still. With removal of vapors for purposes of constant pressure the gaseous hydrocarbons would be high, particularly those of the saturated series. A heavily oxidised oil would yield a higher percentage of liquid within the motor fuel range under similar conditions of operation.

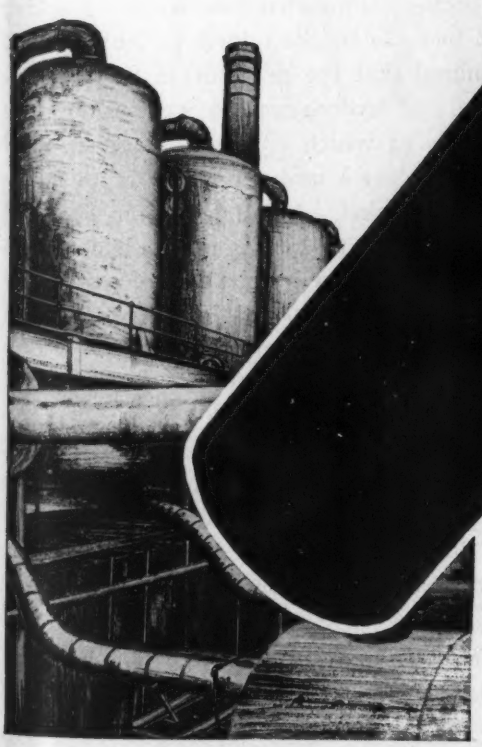
PROPERTIES OF HYDROGEN

Some of the many properties of hydrogen have long been known but there is much yet to learn. It is considered as the protein chemical element because of its fundamental atomic structure. It is the lightest gas known, on compression it behaves as no other gas, as the pv values gradually increase with increasing pressure. Other gases go through maximum and minimum values of pv but the relative energy to mass of the hydrogen molecule prevents distortion in this manner with the exception that increase of pressure increases the activity in a manner that would suggest the active nascent state which is the atomic form. Hydrogen under pressure acts as though nascent, this activity increases with increase of pressure. The properties of nascent hydrogen are familiar to every chemist as it is under such conditions that most reducing actions take place. It has been noted that under 200 atmospheres pressure that compounds of mercury and silver in solution quantitatively are reduced to the respective increase of temperature hastens the preceptitation altho the reaction goes to completion when cold. The oxides of metals are reduced by hydrogen under favorable conditions of temperature and for pressure, hydrogen has the power of permeating many metals including iron at red heat. Metals have the power of occluding or taking up hydrogen in enormous volumes, paladium takes up as much as 900 volumes of hydrogen per unit volume and this is shared to some extent by iron. It would take in excess of 900 atmospheres pressure to make hydrogen occupy the space that it does when occluded with paladiuum so some idea is had

*Section of a B & W Seamless NIROSTA KA2 Tube

after 13,588 hours' service in a cracking coil running West Texas Gas Oil

(unretouched photograph



*This photo shows a section of a B & W Seamless NIROSTA KA2 TUBE which was removed from a cracking coil after 13,588 hours' service in one of the hottest sections of the still. (Removed because steel header box was condemned.)

Such long service naturally suggested an investigation of the physical properties, microstructure and general condition of the tube, to see what changes, if any, had occurred. This investigation showed that nothing had occurred which would have prevented the tube continuing in its regular service.

THE

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of the tremendous energy changes at play between these elements. The remarkable part of hydrogenation as applied to mineral oils is the fact that such a process has not had long commercial application as the specific knowledge concerning hydrogen and its action on carbons and compounds of carbon under pressure has been so long known. The answer probably is found in the fact that motor fuel has been cheap and hydrogen high, also the lack of metals and construction for equipment necessary to withstand the necessary pressures under corrosive conditions. As much credit at least is due to those who developed the mechanical side of oil hydrogenation as is due to the ones who developed the strictly chemical phases. New alloys of steel and recently developed principles of high pressure high temperature design have contributed no small part to successful hydrogenation.

DE POLYMERIZATION

Destructive hydrogenation may be compared to depolymerization which in fact it is to a great extent although it is more than that. Cracking to a considerable extent is a polymerizing process, this taken together with hydrogenation causes the formation of tars and coke, that is small hydrocarbon molecules combine among themselves to form heavier complexes whose molecular weight may be in excess of 2000. The average molecular weight of gasoline may be taken as 100 approximately. Hydrogen forced into proximity to the chemically active smaller molecules prevents them from going toward polymerization by either combining or holding into combinations the already combined hydrogen. It does more than that, for consider the specific illustration $C_{15}H_{32} = C_8H_{18} + 7\ C\ H_4 + 7C$ (Cross) to take place in the presence of hydrogen as follows $C_{15}H_{32} + H_2 \rightarrow C_8H_{18} + C_7H_{16}$. In actual practice of course such perfection as the second equation indicates would not be attained although the tendency would be in that direction. Nascent carbon, if formed would go to hydro-

PRIMARY AND SECONDARY HYDROGENATION

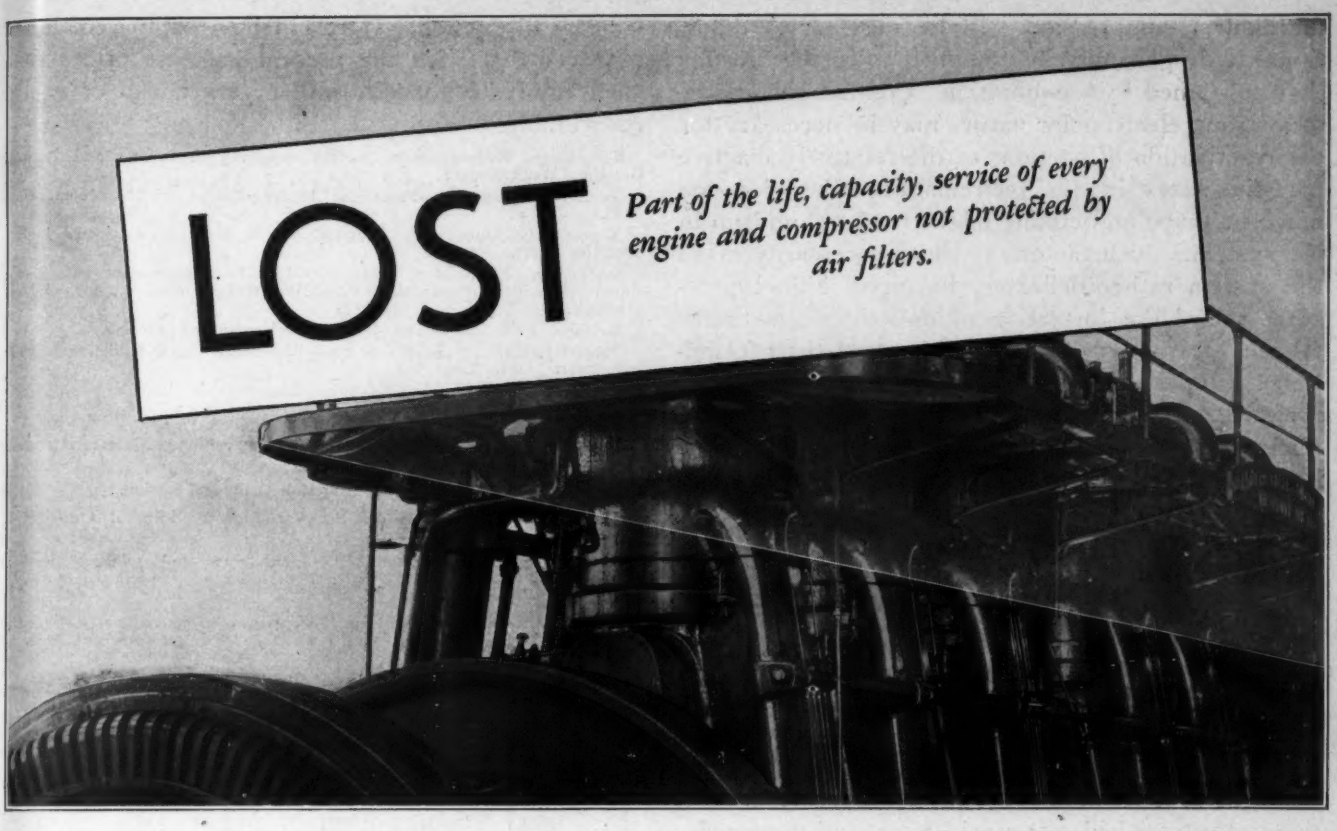
Those familiar with the operation of cracking units, particular of the systems where tube stills are used are familiar with troubles incident to carbonization. This is more pronounced with the heavier oils, the asphaltic oils the worst offenders. Increasing temperature causes more rapid carbonization. Where asphalt base residuums are to be used for conversion stock, a preliminary treatment with hydrogen under high pressure 2500-4000 and at temperatures lower than those used in cracking would so change the nature of the oil that a large part of the carbonization difficulties would be avoided. Under such conditions from asphaltic oil there would be produced a synthetic product more nearly resembling lubricating oil than the original variations in volume of hydrogen and operating pressure could vary the nature down to a paraffin base. At the higher temperatures required for more complete conversion to motor fuel additional hydrogenation would be necessary to meet the needs of the new equilibrium conditions and further prevent the deposition of coke in zones of reaction. Oxygen originally present as a constituent of the asphaltic nature could not escape from a closed system, therefore no deleterrious dehydrogenating force would come from this source.*

The oxygen or sulfur on account of their strong electropolar natures present with a continuous system of hydrocarbons under heat and pressure would assist rather than retard pyrogenesis and hydrogenesis. Oxygen derivitives of hydrocarbon falling within distillation range of motor fuel ofttimes prove valuable as antiknock and anti-carbon constituents of motor fuel. Sulfur of course is undesirable; means must be taken for its separation. The fact that hydrogen combines with sulfur to form hydrogen sulfide suggests methods for the convenient disposal of this injurious element. Oxygen also will replace sulfur from combination with hydrocarbon under favorable conditions before high temperature has driven it into too close combination. The possibilities are almost infinite in number, somewhat similar to cracking only more so because of the added variables. It is to be remembered that the first successful commercial applications of hydrogenation were to organic acids an example of which is the hydrogenation of cottonseed oil to form a lard substitute in the presence of catalytic nickel. A much higher chemical technique is necessary to hydrogenate oleic acid to stearic acid than is required for the wholesale methods applicable to the hydrogenation of mineral oil residuums into motor fuel under pressure.

RECYCLE STOCK

Then the maximum quantity of motor fuel is desired from cracking oils, the fractionated portions heavier than gasoline and lighter than tars and coke is recycled. This may be repeated as many times as necessary for the desired conversion. Each time the stock is recycled it becomes more difficult to convert. Some refiners in addition to the liquid recycle stock also recycle the gases produced from cracking obtaining increased yields of gasoline. In hydrogenation the same applies with the exception that the recycle stock is of higher quality oftimes than the original material or at least can be made so by primary hydrogenation before final conversion. The incondensible gases also must be recirculated for purposes of hydrogen conservation, if vented while hot and under high pressure little additional boost by and under high pressure little additional boost by

*Note.—Where asphalt is made by air blowing oils at suitable temperatures water is formed and carried from the system. This is dehydrogenation, polymerization into heavier asphalt is the consequence as would naturally be expected.



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mechanical compression will be necessary. Additional hydrogen must be supplied to make up for that consumed by combination. Contact substances of a strong electropolar nature may be necessary for the reactivation of portions of the relatively inactive paraffin gases in the recirculation, otherwise too much methane and ethane might tend to build up in the system. Such factors as these necessarily make the system rather delicately balanced, higher pressures retard the formation of undesirable methane, ethane, etc. Oxygen also would retard their formation as under such conditions of temperature and pressure, the hydroxy organic derivatives would likely exist, oxygen showing its preference for carbon over hydrogen.

ISOLATED FACTS AS GENERALIZATION

It has been truthfully stated that the literature of the petroleum industry is one of isolated and uncorrelated records. It is only recently that sustained attempts have been made to gather information that because of its general nature would be of comparative value. Notwithstanding the fact that so little is known of the exact nature of what takes place when an oil is cracked into lighter constituents, practice has established many principles, and these principles form the basis of our present eminently successful commercial process. For those investigators whose creed demands that which is specific and exact, there has been little compensation in the form of useful results. For others more content with visible results for which there is commercial application, better can be said that, regardless of the means employed or the methods used, the maximum yield of the highest quality products from a given material is the objective. As far as hydrogenation is concerned there is the broad back ground of oil cracking back of it, also a wealth of accumulated knowledge both practical and theoretical back of the development of commercial hydrogen. Broad general principles apply to both hydrogenation and cracking, there are still many possibilities for future development in both. High pressure vapor phase is possible in both instances and more especially as applies to hydrogenation. The law of partial pressures holds just as well for a cracking or hydrogenating process as it does for purposes of absorption and fractionation; the gap between physical and chemical phenomena is not so wide as is generally imagined, in fact it is frequently difficult to distinguish where one begins and the other ends.

In a subsequent article the writer will take up specific examples of processes applicable to the hydrogenation of oils. Suggested methods, processes, etc., bid fair to bring forth as many patents as the art of cracking—it would be useless to try to discuss cracking processes in a volume much less an article. The number of catalysts suggested for use in hydrogeneration would of themselves be material for a lengthy discussion. It would be well to remember however that with the present gasoline prices that such catalysts must be either very cheap or easily recoverable.

References: Hydrogenation process appearing in Refiner and Natural Gasoline Manufacturer.

July, 1929, page 66—Plant for Hydrogenation of Petroleum. Geo. Reid.

August, 1929, page 112—Humble Oil & Refining Company hydrogenation plant.

September, 1929, pages 131 and 132—1—Improvements at Baton Rouge include hydrogenation. 2—Humble expansion includes hydrogenation.

January, 1930, page 140—License hydrogenation process.

February, 1930, page 85—lit.cit.—Petroleum research benefits other industries. Geo. Reid.

March, 1930, page 139—Hydrogenation unit in Canada.

April, 1930, page 162—Hydrogenation process will be licensed.

June, 1930, pages 175 and 176—Hydrogenation unit nearing completion.

July, 1930, page 164—Royal Dutch gets hydrogenation.

August, 1930, page 77—The Hydrogenation of Mineral Oils—by I. N. Beall.

August, 1930, page 130—Dept.—Plant men and methods leading companies interested in hydrogenation. Second—Executives to Germany study hydrogenation.

The Oil Weekly, August 1, 1930, pages 62-63, lit. cit.—Refinery Expansion Provides Additional Crude Outlets—Sub-Hydrogenation.

Lubricant Fractions

A STUDY of the lubricant fractions of Cabin Creek, West Virginia, petroleum has been conducted by the United States Bureau of Mines, Department of Commerce. This crude is very similar to most of the Appalachian petroleums, differing from them mainly in that it contains more gasoline and less lubricating stock. The Cabin Creek lubricating stock, moreover, is lighter for a given viscosity than the lubricants from many of the eastern crudes. The study was undertaken with the idea of furnishing data of value in the study of crude oils not commonly used for the manufacture of lubricants.

In Technical Paper 477, by H. M. Smith, just published, price 15 cents, methods have been presented for the preparation on a laboratory scale of lubricating stock from a paraffin-base crude and subsequent fractionation. These methods involve (1) topping by natural gas, (2) dewaxing by cold settling from an acetone-secondary butyl-alcohol mixture, (3) segregation of the lubricating stock by steam distillation, (4) fractionation of the lubricating stock by acetone, and (5) further fractionation of these solvent cuts by both acetone and vacuum distillation.

The cuts and fractions thus obtained were studied by determining their characteristic properties, including viscosity, specific gravity, refractive index, molecular weights, and ultimate analysis. Certain other routine tests, such as those for carbon residue and steam emulsion, were also made. The data indicate that, for a paraffin-base lubricating oil at least, the specific gravity, index of refraction, percentage of sulphur and carbon residue, and relative unsaturation are largely functions of the composition that viscosity is a function of both molecular complexity and composition; and that boiling points, flash points, and associated properties are largely functions of the molecular constitution.

Abstracts of Papers Before Petroleum Chemistry Session

Fall meeting American Chemical Society, September 8-12 at Cincinnati

Following are abstracts of the technical papers presented at the Division of Petroleum Chemistry of the American Chemical Society at the Symposium on "Industrial High Pressure Reactions" at the fall meeting of the society, Cincinnati, Ohio, September 8-12.

THE CONDENSATION OF HYDROCARBONS BY ELECTRICAL DISCHARGE. COMPARISON WITH CONDENSATION BY ALPHA RAYS. *S. C. Lind and George Glockler.*

In a former paper (S. C. Lind and George Glocker. Trans. Am. Electrochem. Soc., 52, 37 (1927), it had been shown that the condensation of ethane by electrical discharge was in many ways similar to the same reaction when produced by ionization due to alpha particles from radon. (S. C. Lind and D. C. Bardwell, J. Am. Chem. Coc., 48, 2335 (1926). These experiments have now been extended to the gases methane, propane, butane and ethlyene.

1. It has been found that the percentage of hydrogen in the methane-hydrogen fraction resulting from the reactions is about 80 per cent in the case of the condensation of the saturated hydrocarbons and a little higher in the case of the unsaturated ethylene. This hydrogen-methane ratio is the same in both the alpha ray and the ozonizer condensation.

2. The pressure changes during the reaction in both types of condensation in much the same manner. In the case of the saturated hydrocarbons the pressure increases and for the ozonizer reaction reaches a miximum after about two hours. In the latter stages of the reaction the pressure decreases again. The maximum pressure reached in the ozonizer condensation is highest for butane and decreases in the order butane, propane, ethane and methane. In the ethylene condensation the pressure decreases to about one-third the initial value. This is the case for both the alpha ray and the ozonizer reaction. The radon condensations of the saturates have, however, not been carried beyond the maximum pressure.

3. The amount of hydrocarbon disappearing to hydrogen appearing $-$H.C. in cc. N.T.P/H_2 in cc. N.T.P.) is of the same order in both the radon and ozonizer reactions; 1.2 to 1.5 for the saturates and 4.4 for ethylene.

4. The empirical composition of the liquid condensate is C_nH_{2n} for the saturates and $C_nH_{1.7n}$ for the unsaturated ethylene. Again both the radon and ozonizer reaction show similar results.

5. A possible mechanism is proposed for these condensations based on the following propositions:

(1) The first reaction step is the ionization of the gas.

(2) The second step is the formation of a cluster.

(3) The formation of a larger hydrocarbon molecule from the simpler ones with elimination of hydrogen and methane.

(4) The ionization of the larger molecule just formed by electron impact.

(5) The formation of an ion of the larger molecule by electron transfer. This mode of ionization is of importance because it favors the larger molecule for further reaction.

6. On the basis of these reaction steps it is possible to construct several probable reaction schemes. However, the number of reaction possibilities by various modes of splitting and recombination make the whole picture a very complicated one indeed and it appears that no completely satisfactory reaction mechanism can be described unless all of the gaseous and also liquid products are known.

7. During the earlier stages of the reaction there appear to be present small amount of unsaturated hydrocarbons which, however, disappear as the reaction is carried on.

8. The study of these reactions has brought to light the fact "that the condensations of the hydrocarbons by radon and in an ozonizer have many points in common and it is natural to suppose that they are brought about by a common agency which are the ions produced in the gases."

THE ROLE OF THE LIQUID STATIONARY FILM IN BATCH ABSORPTIONS OF GASES. I. ABSORPTION. INVOLVING NO IRREVERSIBLE REACTIONS. *H. S. Davis and G. S. Crandall.*

According to the "two film theory" of gas absorption there exists on either side of every gas-liquid interface a layer of unstirrable fluid through which the gas must pass mainly by diffusion. Some of the experimental bases for the conceptions of the "liquid stationary film" are reviewed and expanded. Calculations are given of the rate at which a uniform concentration gradient of dissolved oxygen can be established through the liquid stationary film of water.

The importance of the initial absorption rate is emphasized; that is, the maximum rate at which a gas can be absorbed into the main body of the liquid. Experimental data are given for the initial absorption rate of gases by water and by a few organic liquids under different conditions of agitation.

THE ROLE OF THE LIQUID STATIONARY FILM IN BATCH ABSORPTIONS OF GASES. II. ABSORPTIONS INVOLVING IRREVERSIBLE CHEMICAL REACTIONS. *H. S. Davis and G. S. Crandall.*

The "two film theory" has been extended to gas absorptions involving rapid chemical reactions. The reactions take place entirely in the liquid stationary film. Diagrams are given of the concentration gradients in the film under these conditions.

A general "law" has been developed for calculating the rate of absorption of any gas by a solution, when the gas reacts rapidly with the solute, in terms of solubility of the gas, the concentration of the solution, and the liquid film diffusion coefficient. This generalization is tested by calculations from experimental results of the authors and of other investigators. The results of the investigations carried out under this project on the rates of absorption of olefinic gases by sulfuric acid are reviewed.

THE ROLE OF THE LIQUID STATIONARY FILM IN BATCH ABSORPTIONS OF GASES. III. RATES OF HYDROGEN ABSORPTION AND RELATIVE RATES OF CATALYTIC HYDROGENATIONS IN ALCOHOL. *H. S. Davis and George Thomson.*

Experimental bases are given for the following conception of the mechanism of the hydrogen absorption. The very surface of the liquid is always practically saturated with dissolved hydrogen. From thence the dissolved gas penetrates to the interior of the liquid mainly by diffusion through an unstirrable layer beneath the liquid surface (liquid stationary film). It is distributed through the main body by liquid currents and finally passes thence to the surface of the catalyst by diffusion through another unstirrable layer of liquid existing near the solid-liquid interface. Data are given on the relative rates of catalytic hydrogenation of olefins in mixtures in alcohol.

APPARATUS AND METHODS FOR PRECISE FRACTIONAL DISTILLATION ANALYSIS. *Walter J. Podbielniak.*

This paper presents the history, theory, and author's experimental findings of fractional distillation analysis of gaseous and liquid mixtures. The treatment of the principles of fractional distillation analysis is intended to be very thorough and complete, especially as regards their reduction to actual apparatus design and operation. Various novel forms of apparatus are described, based on fundamental scientific principles, which were found very successful in practice. Analytical procedures are discussed fully. The analytical results presented in this paper are unusual and indicate what may be attained by intensive development of a rather old laboratory art along the lines of fundamental research.

EFFECT OF TIME AND TEMPERATURE ON THE CRACKING OF OILS. *J. C. Geniesse and Raymond Reuter.*

Atmospheric pressure vapor phase cracking experiments were conducted on a representative Mid-Continent gas-oil. Three sizes of apparatus were constructed to enable the time of contact to be varied from 0.75 to 4800 seconds and the temperature from 430 to 700° C. The yields of gasoline, gas and coke and the properties of these products indicates that the main effect of temperature is to increase the rate

of reaction; that is, it is possible to obtain very nearly the same results with either short time high temperature or long time low temperature experiments. An increase of 17° C. halves the time necessary to produce the same results. Recycle experiments on a narrow fraction from a Mid-Continent crude show the increasing refractoriness of the cracking stock.

DETONATION CHARACTERISTICS OF SOME PARAFFIN HYDROCARBONS. *Wheeler G. Lovell, John M. Campbell and T. A. Boyd.*

Engineers have long known that the power and efficiency of the conventional automobile engine could be substantially improved by increasing the prevailing compression ratios, but that progress in this direction is definitely limited by the tendency of present-day gasolines to knock. Although it is generally understood that there is considerable variation in the tendency of different commercial gasolines to knock, the magnitude of this variation is small as compared to that which is possible.

It was pointed out as many as ten years ago that different classes of chemical compounds exhibited widely different tendencies to knock. For example, the paraffin hydrocarbons and ethyl ether were shown to have a greater tendency to knock than substances like benzene and ethyl alcohol. More recently it has been found that large differences in tendency to knock may exist among the paraffin hydrocarbons themselves. Thus normal heptane was found to be a fuel of very low antiknock quality in comparison with 2,2,4-trimethyl pentane, a fuel of high antiknock quality. Differences in knock rating have also been reported among some of the isomeric octanes.

The aim of the present paper is to extend this existing knowledge to include 26 paraffin hydrocarbons. This work was begun in 1926 as part of a program to gather data upon the relative detonation characteristics of pure substances suitable for fuel in an engine which would be comprehensive enough to establish the relationship between structure and detonation characteristics. It is believed that the data presented here form a fairly consistent picture of this kind for the paraffin hydrocarbons boiling within the gasoline range.

The knock ratings of these hydrocarbons have been determined in admixture with a regular commercial gasoline in the amount of one gram mol of the hydrocarbon to a liter of gasoline. These knock ratings found have been expressed on a common molecular basis, using the antiknock effect of aniline as the standard of comparison.

Upon this basis a definite relationship between molecular structure and tendency to knock has been found for these compounds. This relationship may be summarized in the statement that in a homologous series the tendency to knock increases with the increasing length of the carbon chain, and in an isomeric series the tendency to knock usually decreases as the number of side chains is increased. The successive introduction of methyl groups into a carbon chain of given length also decreases the tendency to knock.

FOLLOWING COMBUSTION IN THE GASOLINE ENGINE BY CHEMICAL MEANS. *Lloyd Withrow, Wheeler G. Lovell and T. A. Boyd.*

Measurements have been made of the oxygen concentration in gases withdrawn from the cylinder of a gasoline engine with a new and improved sampling valve which was located at different places in the combustion chamber and opened at different times during the combustion of the charge.

These data show a narrow combustion zone proceeding through the combustion chamber at a finite rate. The progress of the zone is slower near the walls of the combustion chamber than through the middle portion of the combustion space. Over the range investigated it is increased with engine speed and unaffected by spark timing.

The presence of "knock" in the range investigated did not affect the movement of the zone during the first three-quarters of the distance traveled, but the knock occurred during the time that the last part of the charge burned. Experiments to find out more as to the nature of this final phenomenon during knocking combustion are now in progress. The elimination of the knock by lead tetraethyl did not affect the movement of the combustion zone in the first portion of the combustion space.

THE CHEMICAL NATURE OF THE GUM-FORMING CONSTITUENTS OF GASOLINE. *Donal T. Flood, J. W. Hladky and Graham Edgar.*

A number of unsaturated hydrocarbons of various types have been synthesized and blended in various proportions with straight-run gasoline. These mixtures have been subjected to several tests for gum, including treatment with oxygen under pressure. Tentative conclusions have been drawn as to the type of chemical compound most likely to form gum in gasoline, and as to the interpretation of the various tests employed.

SOME FACTORS AFFECTING THE CATALYTIC ACTIVITY OF COBALT OLEATE ON THE AUTOXIDATION OF PENTENE-2. *Julius Hyman and C. R. Wagner.*

Cobalt oleate was prepared by several methods, and its catalytic activity on the autoxidation of pentene-2 noted. It was found that acids and bases exert considerable influence on this activity. Preliminary oxidation of the cobalt oleate produced a product which caused the disappearance of the "induction period" in the autoxidation of the olefin. Here, also, acids and especially bases were influential in determining the rate of autoxidation. An attempt has been made to bring these results under a viewpoint similar to that proposed by the authors for "unpromoted" autoxidations. A series of equations is given showing the possible course for the reactions in question.

THE REACTIONS WHICH OCCUR ON A METHANOL CATALYST. *David F. Smith and Lester L. Hirst.*

It has been shown that CO_2 and H_2 react upon a $ZnO\text{-}Cr_2O_3$ catalyst at 304° C. to form CH_3OH, CO and H_2O. Likewise CO and H_2O react to form CO_2 and H_2 and equilibrium can be closely approached in the water gas reaction. Of the reactions which may occur through the action of $ZnO\text{-}Cr_2O_3$ catalyst at 304° C. upon H_2 - CO_2 - H_2O mixtures, it has not been found possible to determine which reaction comes nearest to equilibrium. Since most methanol catalysts of which we have knowledge, produce CO_2 or H_2O or both along with methanol, the possibility is suggested that the formation of methanol from CO and H_2 may not be direct, especially as a steady state is approached.

CATALYTIC HYDRATION OF OLEFINES. *S. Swann, R. D. Snow and D. B. Keyes.*

A study has been made of the conditions for the catalytic hydration of olefines under pressure to alcohols.

It has been found that the equilibrium concentration of alcohol is small at pressures below 800 pounds per square inch, using dilute solutions of halogen acids and salts as catalysts at temperatures below 200° C.

In increasing the concentration of HBr and HI favors the formation of the alkyl halide without apparently increasing the alcohol formation thus indicating the catalytic action of the halogen acid.

THE METHANOL EQUILIBRIUM. *Edward F. Von Wettberg, Jr., and Barnett F. Dodge.*

In spite of all the published work on this subject there are still some striking discrepancies to be cleared up. Previous workers have attacked the problem from three angles: (1) Calculation of the equilibrium constant (Kp) via the third law of thermodynamics making use of absolute entropies or by means of the Nernst approximation, (2) indirect measurement of Kp by experimental study of equilibrium for reactions whose combination yields the methanol synthesis reaction and (3) direct determination of Kp for the methanol reaction ($Co + 2H_2 = CH_3OH$) at atmospheric and higher pressures.

The experimental investigations agree only as to order of magnitude, the disagreement being as much as several hundred per cent. Only a small part of this discrepancy can be accounted for by the effect of pressure on Kp. This is treated in detail in the paper and values of Kpo (equilibrium constant at low pressures, where gases are substantially ideal) are calculated with the aid of Van deWalls Equation. The equilibrium constants calculated via the third law (those based on the Nernst approximation are omitted from consideration) are anywhere from 12 times to 1500 times the experimental ones. It is believed that a large part of this difference may be accounted for by inaccuracies in the thermal data, though this has been disputed by others.

Some new experimental data obtained by the direct method at 170 atmospheres and temperatures ranging from 260 to 310° C., are presented. These data must be regarded as preliminary, but it is believed that they represent an improvement over the previous data obtained at pressures higher than atmospheric. The constants agree fairly well, at the lower temperatures, with those obtained in the one published investigation by the direct method at 1 atm. and are considerably higher than those obtained in two investigations at higher pressures.

The results of previous investigations are critically compared with these new data and various sources of error in the experimental determination of kp's and their interpolation and extrapolation by means of thermal data are discussed. The influence of side reactions on the experimental measurements is particularly stressed. The new data still leave an enormous gap between experimental and calculated results.

THE SPECIFIC HEATS OF GASES AT HIGH PRESSURES 111 RESULTS FOR NITROGEN TO 150 C. AND 700 ATMOSPHERES. *B. H. Mackey and Norman W. Krase.*

Two previous papers have described methods and apparatus for measuring specific heats of gases at ordinary and at elevated temperatures and at high pressures. The present paper gives results for nitrogen at 30°, 50°, 100°, 125° and 150° C. and up to 700 atmospheres.

At all pressures the specific heat of nitrogen decreases with temperature. At all temperatures the specific heat increases with pressure, the effect being greatest at lower temperatures. The effect of pressure, in the range above 400 atmospheres, is small; the specific heat being almost independent of pressure especially at ordinary temperatures.

CATALYSTS FOR THE FORMATION OF ALCOHOLS FROM CARBON MONOXIDE AND HYDROGEN. VI. AN INVESTIGATION OF THE MECHANISM OF FORMATION OF ALCOHOLS HIGHER THAN METHANOL. *Per K. Frolich and S. D. Cryder.*

In continuing the study of the high pressure synthesis of alcohols from mixtures of carbon monoxide and hydrogen, experiments have been made to investigate the mechanism of formation of alcohols higher than methanol. By studying the behavior, under the conditions of high pressure synthesis, of the individual compounds which might conceivably

(*Continued on page* 138)

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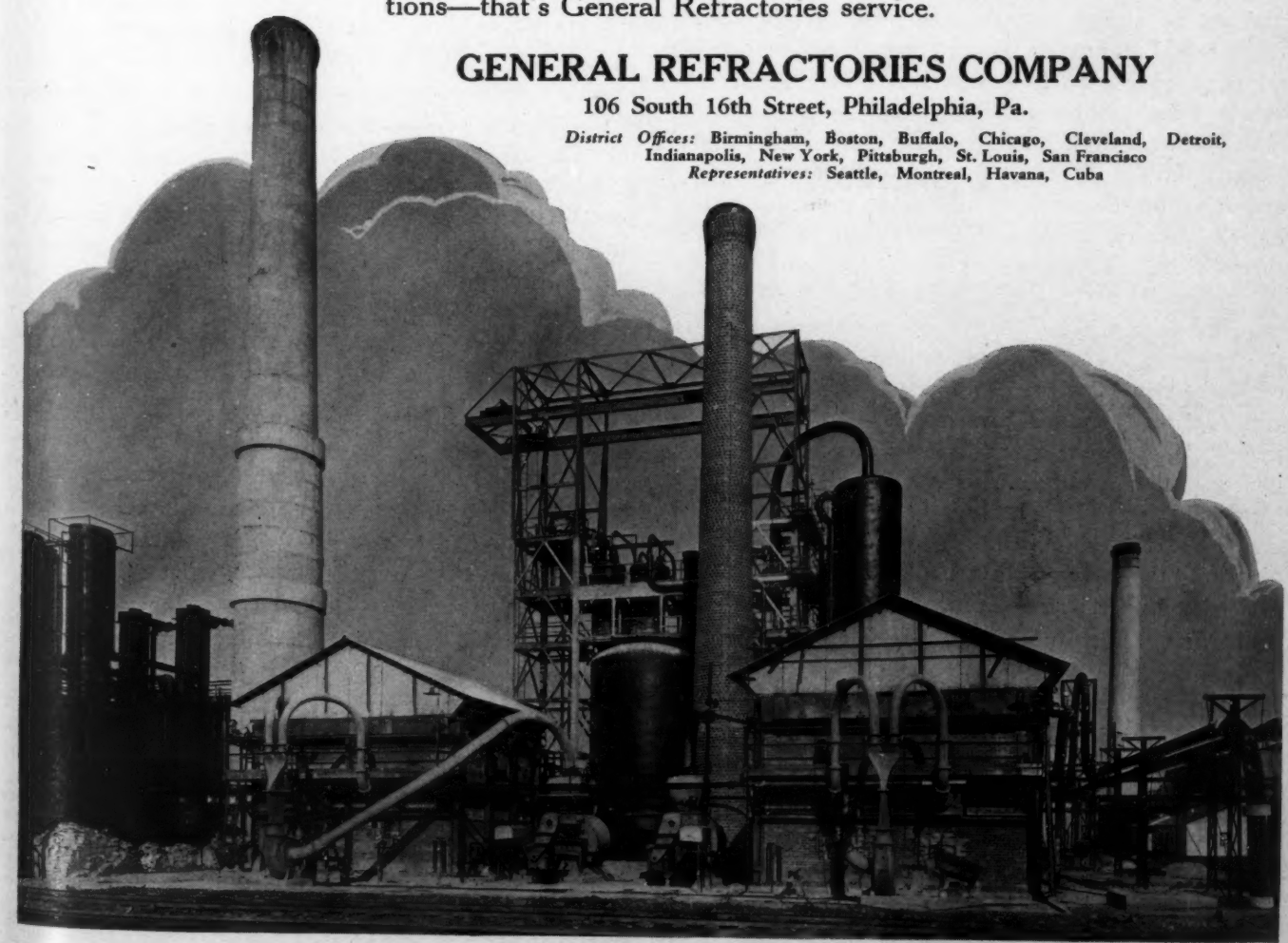

PLANT MEN AND METHODS

By GEORGE REID

Reports Accident

"ON April 16 I was called to a plant close to the ———Camp that a man had fell in a gas engine and got killed and wanted me to help get him out of the engine, on arriving I found that he had been oiling the engine while it was running, the oil and grease was from ½-inch to one-inch deep on the engine house floor and he had climbed up on the front of the engine block to fill an oil cup on the right journal and slipped and fell in to the crank of the engine, the crank hitting him in the jaw breaking his neck and throwing him through the left fly wheel as far as his waist line, the engine running caused the lower half of his body to pass between the fly wheel and the concrete engine block which is a space of three inches, the upper half of his body passing between the fly wheel and the concrete fulcrum stand a distance of approximately six inches, as he went around the wheel he pulled the igniter push rod out helping to shut the engine down, his shoulders and head hitting the reverse rod threw the clutch out, the engine only turned over once and stopping with the body on the front of the engine, when I arrived there he was laying on his back over a spoke in the fly wheel with his intestines laying over the next spoke above the one the body was laying on, myself and three of my men removed the body from the fly wheel and layed it on the floor and waited the arrival of the undertaker, there wasn't a bone in his body that wasn't broken."

Instruction in safe practices and "Good Housekeeping" will prevent such accidents.

From National Safety Council, Petroleum Section, News Letter, Gulf Division, July, 1930—which was edited by R. B. Roaper, Humble Oil & Refining Company, Chairman, Gulf Division.

Edeleanu Process and Gasoline

THE Edeleanu method of refining petroleum distillates by liquid sulphur dioxide has proved of value in refining of kerosene and lately in the treatment of lubricating oils, but hitherto has not been particularly useful for refining motor fuel, according to Petroleum Times, London, in reporting work of L. Edeleanu and W. Grote as it originally appeared in Brennstoff-Chemie, of June 1. These investigators report a treatment of motor fuel distillates with liquid sulphur dioxide where in a fuel is produced with very high anti-knock value.

The liquid sulphur dioxide dissolves the aromatic and unsaturated hydrocarbons in the form of an extract, which is separated and the anti-detonant series returned to the motor fuel. It is explained that cracked motor fuel fractions show less tendency to knock than straight run gasoline, but still the anti-knock value is usually too low. The authors say that this condition may be improved by a modification of the liquid sulphur dioxide refining process; they have found that the relatively high temperature boiling fraction—175° C. (347°F.) to 220°C. (428°F.) of motor fuel is the portion that induces knocking. This fraction is separated from the distillate, treated with liquid sulphur dioxide, and the extracted aromatics and unsaturates returned to the lighter part of the distillate. Through this means gasolines of premium grade may be made to order. It is the only well known means of separating saturates from unsaturates, and so on, and gives the chemist opportunity to design and build a gasoline to his liking, either commercially or experimentally. This way the principle constituents are removed and the proportions of the aromatic and unsaturated hydrocarbons is thus so increased as to produce a fuel practically without tendency to knock at ordinary compression ratios used in motor operation. Moreover the volatility of the whole fuel is increased, and as compensation for the removal of the fraction mentioned, the end point can be increased.

Another source for small quantities of aromatics and unsaturates of correct boiling range for inclusion in the gasoline is the recovery of these hydrocarbons from the extracts produced when kerosene is treated for their removal by the liquid sulphur dioxide process.

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WHEN G-R Submerged Bentube Sections were first installed at the plant of W. H. Daugherty & Sons Refining Co., a subsidiary of L. Sonneborn Sons, Inc., New York City, many of the operating men were extremely dubious as to their suitability, even for ordinary condensing service.

The superiority of these sections over the pipe coils previously used became quickly apparent, however. With little more than half the surface, the Bentube Sections gave better condensing results, enabled the operators to control their distillation much more accurately, required a smaller amount of cooling water, cost considerably less, and were far more compact.

The sections were subjected to test after test, until the heaviest stocks handled in the plant were run through them. Each time, highly satisfactory results were obtained, and the men at the plant are now heartily enthusiastic about their performance.

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But small quantities are removed from kerosene of boiling range suitable for gasoline, but their recovery for this purpose may be cheaply accomplished by redistillation in a blend with crude, pressure distillate, and other products requiring two distillations.

The authors state that where the high boiling fraction over 175°C. (347°F.) is high in aromatics the antiknock value of the resulting motor fuel will be higher. They also refer to the fact that sulphur dioxide extracts have a somewhat higher sulphur content than that of cracked distillate so that the addition of the extract obtained from the high boiling fraction to the lighter part of the distillate tends to increase the sulphur content of the latter.

Natural Gasoline Plants

NATURAL gasoline plants in the United States number 1035 with a total daily capacity of 10,516,000 gallons, January 1, 1930, according to Bureau of Mines survey Information Circuit 6279. Number of plants in 1928 was 1155—and while the number of plants has decreased by 120, the capacity has increased 2,468,000 gallons. Over half of the increase occurred in California.

Of the total plants 999 were operating on January 1, 1930, and 36 were shut down. Daily capacity of operating plants was 10,278,000 gallons. The industry is 98 per cent in operation and two per cent shut down. Average daily production for 1929 was 6,015,000 gallons, indicating operations at 61 per cent of total capacity.

Oklahoma operators dismantled 60 plants in 1929, but still leads in number of plants having 268. California has 165 plants but leads in daily capacity with 3,658,000 gallons. Oklahoma was second with 3,085,000 gallons. General Petroleum Corporation in California has the largest plant, with Sinclair Oil & Gas Company having second largest plant at Seminole, Oklahoma. Seventy-six per cent of the capacity is represented by the absorption extraction method, with charcoal and compression methods totalling 24 per cent of capacity.

Standard "Doctor" Test Methods

IN regard to the lack of standardization of application of the doctor test for determination of sweetness or sourness of gasoline or kerosene, Dr. T. G. Delbridge, supervisor, process division, Atlantic Refining Company, has given us the method of his company for publication, concerning which he writes as follows:

"While Committee D-2 of the American Society for Testing Materials voted by a considerable majority that standardization of the methods for carrying out the so-called doctor test is not desirable, I know from the experiences of many refiners in connection with complaints on sourness in gasoline that differences of opinion are in considerable degree due to lack of a standard procedure in carrying out the test.

"Atlantic Refining Company's inspection department which is under the direction of H. M. Hancock, has for many years employed A.S.T.M. standard methods for petroleum testing. Since such methods do not completely cover the field of tests it has been necessary for us to devise our own methods and we have standardized them ourselves along the same general lines as A.S.T.M. methods including general adherence to A.S.T.M. form. A copy of Atlantic Refining Company method for doctor test is attached. This method has also been forwarded to A. J. Kraemer, Bureau of Mines, Washington, D. C.

"I suggest that credit for this method should be duly given to H. M. Hancock, superintendent, inspection department; and to Dr. H. V. Hume, of our research staff."

Atlantic Refining Company method for "Detection of compounds in light petroleum distillates which react with sodium plumbite."

SCOPE

This method is the well known "Doctor" test and is applicable to naphtha and kerosene.

APPARATUS

The test shall be carried out in standard cylindrical four ounce sample bottles, the inside diameter of which shall be approximately 33 mm. The bottles shall be fitted with clean cork stoppers.

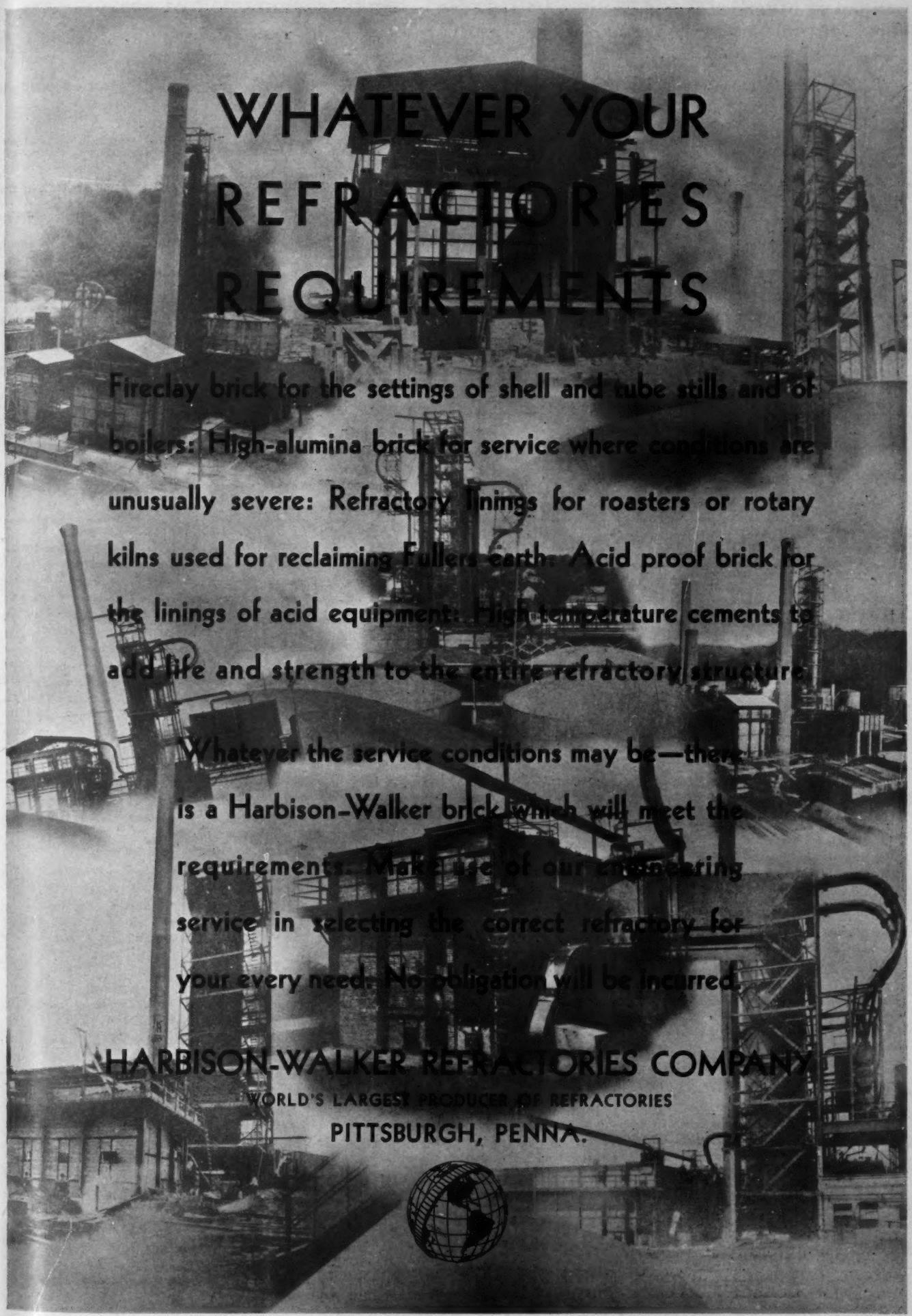
REAGENTS REQUIRED

(a) *Sodium plumbite (doctor solution)*. A plumbite solution shall be prepared containing 120-140 grams of NaOH per liter and 20-30 grams of PbO per liter.

NOTE: Considerable experience with this test indicates that the procedure for preparing the plumbite solution as recommended in the Bureau of Mines Method 520.3 in 323B results in solutions of widely varying lead content. To obtain accurate uniform results it is advisable to use solutions of the concentration indicated.

This solution is most conveniently prepared by dissolving approximately 125 grams of NaOH in one liter of distilled water, adding 60 grams of PbO and agitating the mixture with air for a period of 6-8 hours at a temperature of 150-175°F. After cooling to room temperature, the solution may be brought back to its original volume by addition of distilled water. Undissolved litharge should be allowed to settle out and the clear liquid should be siphoned off into a container protected from the air. Filtration through an asbestos mat may be employed if the solution does not settle clear.

(b) *Sulfur*—Pure dry flowers of sulfur, ground and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screened to 100-200 mesh shall be used and shall be kept in a closed container to protect from dust.

PROCEDURE

To five cubic centimeters of the plumbite solution in a standard test bottle add 10 cubic centimeters of the sample to be tested.

NOTE: Given a standard plumbite solution, the two most important variables are the volume of sample to be tested and the interfacial area between the sample and the plumbite solution. Both of these factors determine the concentration of the dark precipitate which discolors the sulfur film and is used as the criterion of judgment as to whether a sample is doctor sour or not.

Stopper tightly with a clean cork and shake vigorously for 15 seconds. Add a quantity of pure dry sulfur just sufficient to cover the interface between the sample and the plumbite solution, stopper the bottle, shake vigorously for 15 seconds and allow to settle.

NOTE: It is important to avoid the addition of more sulfur than will just cover the interface, otherwise the dark precipitate will be diluted by the excess sulfur and the interpretation of the test thereby affected. With finely ground sulfur, as specified, 20-25 milligrams is the proper quantity. This amount can be accurately estimated with a little practice.

INTERPRETATION OF RESULTS

If on agitation of the plumbite treated sample with sulfur, the sulfur film becomes discolored or flecked with brown or black, the test shall be reported positive and the sample considered "sour."

NOTE: In many samples which have been examined, it has been noticed that if the sample is even slightly sour a colored "lace like" emulsion tends to form between the sample and the plumbite solution.

When agitation of the plumbite treated solution with sulfur results in no discoloration of the yellow sulfur film, the test shall be reported negative and the sample considered "sweet."

NOTE: The appearance of an immediate black precipitate on the addition of the sample to the plumbite solution is indicative of the presence of hydrogen sulfide. If no immediate precipitate is formed but the sample becomes opalescent and much darker in color after shaking with the plumbite solution, the presence of dissolved elemental sulfur and mercaptans is indicated. In the presence of mercaptans and absence of hydrogen sulfide and dissolved elemental sulfur a clear yellow solution of varying intensity usually results.

Abstracts of Papers Before Petroleum Chemistry Session

(*Continued from page* 132)

be formed as intermediates, it has been possible to arrive at rather definite conclusions concerning the mechanism of the reactions.

With methanol as an intermediate product the higher alcohols are chiefly formed by successive condensations of lower ones. The overall rate of this step-wise process is apparently controlled by the initial condensation of methanol to ethyl alcohol, $2\ CH_3OH = C_2H_5OH + H_2O$, and the ease with which farther condensation takes place explains why ethyl alcohol constitutes only a minor part of the product. The use of carbon monoxide in excess favors the formation of higher alcohols because water vapor liberated by the condensations is thereby removed from the catalyst surface by the reaction $H_2O + CO = CO_2 + H_2$. This reaction also accounts for the large production of carbon dioxide in the higher alcohol synthesis. The acids formed are chiefly present as esters, and the evidence points to the direct production of these esters by polymerization of aldehydes, (e.g., $2\ CH_3CHO = CH_3CO\ OC_2H_5$) rather than to the intermediate production of acids by addition of carbon monoxide to methanol (e.g., $CH_3OH + CO = CH\ COOH$.)

ADSORPTION OF METHANE AND HYDROGEN ON CHARCOAL AT HIGH PRESSURE. *Per K. Frolich and A. White.*

Adsorption isotherms of methane and of hydrogen on charcoal have been determined over the pressure range of 1 to about 150 atmospheres at temperatures of 25° and 100° C. for hydrogen. The amount of gas adsorbed increased markedly with pressure approaching a saturation value at 80-100 atmospheres. At 25° C. the maximum adsorption is approximately 12 and 4 liters per 100 grams of charcoal for methane and hydrogen, respectively.

Experiments with mixtures of methane and hydrogen under pressure at 25° C. have shown that charcoal adsorbs methane preferentially to the practically complete exclusion of hydrogen. The amount of methane adsorbed is approximately equivalent to that which would be adsorbed if the gas were present alone at a pressure equal to its partial pressure in the mixture.

STUDIES ON THE MECHANISM OF AMMONIA SYNTHESIS OVER IRON CATALYSTS. *P. H. Emmett.*

Measurements by various workers have shown that small but definite quantities of nitrogen, of hydrogen and of ammonia are adsorbed by pure or promoted iron synthetic ammonia catalysts. There is no apparent relationship between the amounts of these gases adsorbed and the activity of the catalysts. Ionization potential measurements of Kistiakowsky indicate that nitrogen adsorbed on iron catalysts may be present as atoms. Incomplete kinetic measurements indicate that the rate of synthesis of ammonia from hydrogen-nitrogen mixtures is inhibited by ammonia.

Poisoning experiments by Almquist and Black, and by Emmett and Brunauer show clearly that in the presence of water vapor-hydrogen ratios much smaller than those corresponding to equilibrium in the system Fe-H-O, definite amounts of surface oxide are formed on iron catalysts. These results indicate the existence of iron atoms on the catalyst surface having much higher free energies than those in the lattice of massive iron. Recently, experiments have shown the dissociation pressure of Fe_4N to be about 5000 atmospheres at 450 C. Calculations show that nitrogen at a partial pressure of only a few atmospheres should be capable of reacting with surface iron atoms to form a surface nitride. At first pointed out by Frankenberger, the formation of such a nitride probably plays a part in the synthesis of ammonia from hydrogen-nitrogen mixtures over iron catalysts. Iron atoms vaporize from a hot wire through an atmosphere of hydrogen at a pressure of about 10^{-3}mm. to an ice-coated-glass surface cooled in liquid air have been found by Frankenberger and Mayerhofer to combine with hydrogen in the ratio of one iron atom to one hydrogen molecule. A similar linkage between the active surface iron atoms and molecular hydrogen may constitute a portion of the machanism of ammonia synthesis.

Promoters added to iron synthetic ammonia catalysts have been shown by Wyckoff and Crittenden to definitely retard the growth of iron crystals in the catalyst, thereby helping to retain a larger surface in promoted iron catalysts than in pure ones.

HYDROGENATION OF OILS. *R. T. Haslam and R. P. Russell.*

This paper deals with some of the recent developments in the hydrogenation of petroleum and shows the adaptability of the process for converting fuel oil to gasoline and gas-oil, increasing the paraffinic nature of kerosenes, burning oils, and lubricants, and discusses the reverse possibility of producing non-paraffinic gasoline. There is pointed out the flexibility of the process particularly with respect to changes in the characteristics of the product, the handling of a wide variety of charging stock, the elimination of all forms of sulphur and the conversion of all asphalts to distillate fuels.

THE CONDENSATION REACTIONS OF ACETALDEHYDE OVER CERTAIN OXIDE CATALYSTS AT PRESSURE OF FROM 1 TO 500 ATMOSPHERES OF HYDROGEN. *Homer Adkins, M. E. Kinsey and K. Folkers.*

Apparatus is described for carrying out reactions of organic liquids under pressure in the vapor state in an atmosphere of hydrogen. The experimental work is reported in two parts, one dealing with the effect of pressure, temperature, rate of flow, composition of catalyst, water content, etc., on the ratio and rate of formation of hydrogen and ethylene and the other with the effect of these variables on the character of the liquid products.

The liquid products are in all cases complicated mixtures which were partially fractionated and then reduced over nickel catalysts. A list of compounds and yields are given ranging from ethyl alcohol and acetaldehyde through esters of acetic, butyric, and caproic acids and alcohols higher than octyl. Equations suggesting probable mechanisms are given for these products.

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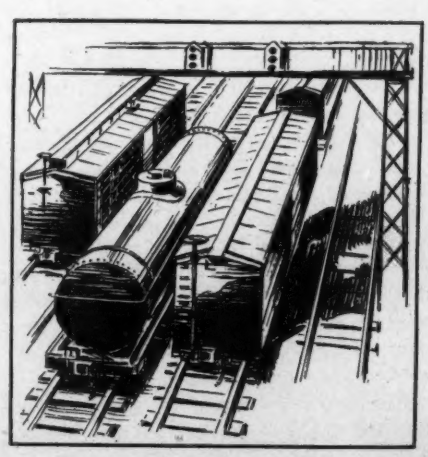

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Refineries and Gasoline Plants Continue Expansion

REPORTS covering the past 30-day period are indicative of continued expansion in the petroleum refining industry for 10 new plants were announced or proposed in August. This work if carried to completion will add 40,000 barrels crude oil capacity to the industry's total by next spring. Reports indicate a slackening in construction of natural gasoline plants during the past 60 days.

Pure Oil Company has announced construction of a 6000-barrel plant at Toledo, Ohio, which is to be equipped with Gyro vapor phase cracking units. In the same state Independent Producers Refining Company has been incorporated and will erect a refinery at Logan of 2000 barrels capacity, equipped with Dubbs cracking units. Among the proposed plants is that reported in the press for General Petroleum Corporation on its 300-acre site at Torrance, California, and a plant for Cosden Oil Company to be leased or possibly built on the Eastern seaboard. Also, in California, Mohawk Petroleum Company is building a 4000-barrel skimming plant near the new Playa del Rey field close to Venice.

Texas Pacific Coal & Oil Company is buying materials for a proposed refinery of 3000 barrels capacity at Temple, Texas. At Corpus Christi Houston Oil Company has started operating a small single-still plant, while reports state plans are being made for the large permanent plant at this point. Continental Oil Company is reported proposing a refinery at Billings, Montana. D. M. Crump Refineries, Inc., is building a 2500-barrel skimming plant in the south part of the Oklahoma City field. Black Gold Refining Company has started operating its recently completed plant in this field, and reports state that Altitude Petroleum Company contemplates the erection of a 2000-barrel refinery there.

Several companies are enlarging refining facilities. White Oak Refining Company at Allen, Oklahoma, is adding a new lubricating oil department which will soon be in operation. Sunray Oil Company, also operating plant at Allen, Oklahoma, is doubling crude capacity through the installation of new tube stills. Peveto & Peacock Refining Company, Oklahoma City, in addition to moving plant equipment in from Kansas, have erected a new tube still unit. In Pennsylvania Crew-Levick Company (Cities Service), has completed erection of its combination crude and re-run units, thus doubling the capacity of this plant and greatly increasing production of its lubricants. Union Oil Company, Wilmington, California, plant, is adding another unit of the Edeleanu sulfur dioxide treating process, as is Humble Oil & Refining Company at its Baytown, Texas, plant. Four other Edeleanu units are being installed at various foreign refineries.

Vacuum Adds Two Units

Vacuum Oil Company, after experimental operation of the Pratt vapor phase units at the St. Louis refinery of Lubrite Refining Company, is adding two additional vapor phase units of this type. Enlargement of the Paragon refinery at Toledo, Ohio, by Gulf Refining Company is to consist of the installation of two 9000-barrel tube stills, thus trebling capacity at this plant. In Texas, Olney Refining Company, recently purchased by Reese Allen and associates, is reconditioning and enlarging capacity through the addition of another tube still unit.

White Star Refining Company, operating refineries at Trenton, Michigan, and Wood River, Illinois, has been acquired by Vacuum Oil Company, and it is rumored that the Bartles-Maguire-Waghams Oil Company deal is progressing toward culmination soon. The often mentioned merger of Phillips Petroleum Company and Independent Oil & Gas Company was announced last month with plans for no change in personnel or headquarters of either company. Cities Service Company is negotiating for the acquisition of Louisiana Oil Refining Corporation with refineries at Shreveport, Louisiana, but definite announcement of completion of merger plans have not been announced. Deer Oil Corporation has been organized to take over the Luling and Brownwood, Texas, refineries formerly operated by Central Texas Refining Company.

Pure Oil Company is nearing completion of construction of its Van field, Texas, compression type natural gasoline plant, equipment for which was mostly dismantled in Oklahoma plants and moved to Van. Development of the field points to the necessity of a second natural gasoline plant for this field outside the unitized area. The Del Rey Oil & Refining Company has started operating its new natural gasoline plant near Venice, California.

Refineries discontinuing operation during last month consist of MacMillan Petroleum Corporation's El Dorado plant, shut down upon completion of the company's new refinery at Norphelt, Arkansas, and the three refineries formerly listed as Transcontinental, which are now called Mid-Kansas Oil & Gas Company, and now a subsidiary of Ohio Oil Company. The Fort Worth plant was scheduled for early resumption of operation. The Boynton and Bristow, Oklahoma, plants will be inoperative for longer periods, during which time they are to be reconditioned. Peerless Oil & Refining Company at Chanute, Kansas, was shut down, and Empire Oil & Refining Company announced shutting down its Cushing, Oklahoma, refinery for an indefinite period.

Refinery at Thrall, Texas

All-State Refining Company has been designated as the name for the 3000-barrel daily capacity refinery nearing completion on the I. & G. N. Railroad near Thrall, Texas. Headquarters of the company will be located at Corsicana, Texas. H. H. Coffield of Rockdale, Texas, is president of the company, and Geo. P. Mann will be plant superintendent. The latter was formerly superintendent for the Central-Texas Refining Company, and has had active charge of construction work on the Thrall plant. C. A. Middleton, former president of Central Texas Refining Company, is also identified with All-State Refining Company. An ample crude supply is to be obtained from the nearby Chapman field through a contract held with Williamson County Pipe Line Company.

Altitude to Build

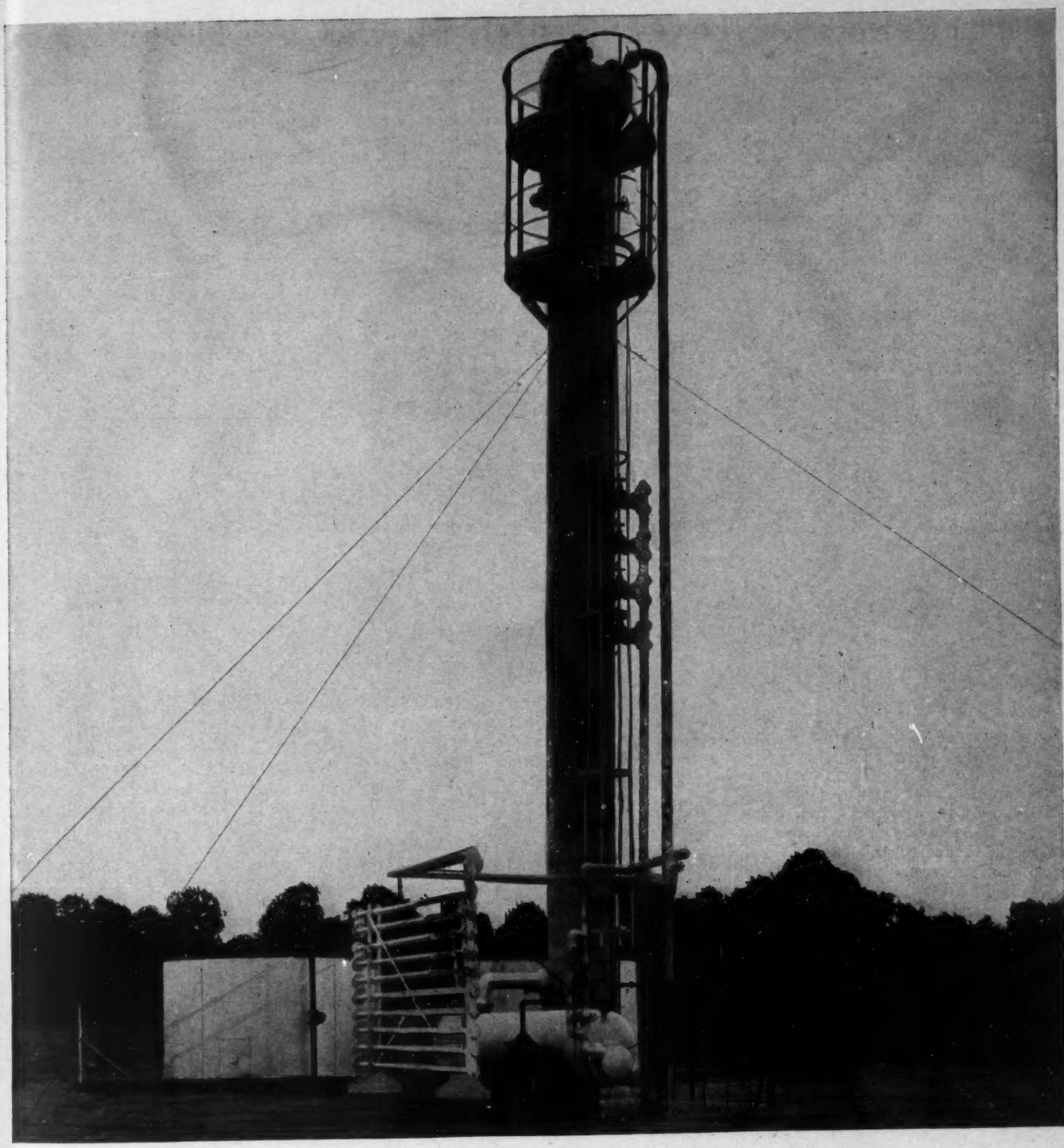
Altitude Petroleum Company, according to recent items in the scientific press, is to build a 2000-barrel plant at an estimated cost of $250,000, for refining of petroleum.

Chile Plans Refinery

Chilean government will be asked to appropriate money, at the next meeting of the Congress, with which to build or buy oil refineries to be operated on crude oil imported from Peru or California. The program has as its aim the lowering of cost to the consumer of petroleum products in Chile, South America.

Cities Service May Buy Loreco

Cities Service Company is reported negotiating with Louisiana Oil Refining Corporation, Shreveport, with the view to purchasing this producing, refining and marketing organization. The Shreveport company has a rated refining capacity of 23,000 barrels with refineries at Bossier City and Gas Center, Louisiana. It has retail and wholesale outlets throughout East Texas, Louisiana, and parts of other



A TYPICAL INSTALLATION OF TULSA TYPE FRACTIONATING EQUIPMENT

Tulsa, Oklahoma,
2020 South Union Street

TULSA
Boiler & Machinery Co.

Oklahoma City, Oklahoma
443 Commerce Exch. Bldg.

TULSA OKLAHOMA

NATURAL GASOLINE PLANTS TANKS REFINING EQUIPMENT

REFINERY AND GASOLINE PLANT ACTIVITIES

southern states, having sold its northern marketing facilities some time ago. Louisiana Oil Refining Company is reported to be installing its own vapor phase system of cracking which has been developed by company engineers. This will operate in conjunction with its nine liquid phase Tube and Tank cracking units.

Proposed Montana Refinery

Continental Oil Company, according to repeated items in Wyoming newspapers, is contemplating the erection of a modern refinery at Billings, Montana; capacity to be 2000 barrels.

New Cosden Refinery

Cosden Oil Company, Fort Worth, plans operation of an eastern seaboard refinery which will be either a newly constructed plant or the operation of one of the eastern refineries now shut down under lease. Item in Industrial and Engineering Chemistry states Cosden will build at cost of $300,000, private plans. New York dispatches state it is understood that a refinery in New Jersey will be leased or purchased, and crude supply will be obtained by tanker.

Crew-Levick Complete Two Stage Unit

Crew-Levick Company (Cities Service) at Titusville, Pennsylvania, has completed and is operating its new two-stage atmospheric vacuum distillation unit and pressed distillate rerun unit. The crude unit is rated at 3000 barrels daily, taking gasoline overhead and seven side streams, with steam refined cylinder stock off the bottom of the column. The tower of the crude unit is 131 feet in height. The rerun unit is designed to handle both pressed distillate and solution rerun material. The units were designed and erected by Foster-Wheeler Corporation The construction of similar equipment at the Empire refinery at Ponca City, Oklahoma (Cities Service), is nearing completion.

Six Plants at Oklahoma City

D. M. Crump Refineries, Inc., is building a 2500-barrel plant in the south part of the Oklahoma City field on the Frisco railroad. Sixty-four service stations and five bulk plants will also be operated by the company. It is reported that C. C. Julian is negotiating for control of this company, and that he is also substantially interested in Peacock and Peveto Refining Company, the other building plant in this territory.

Black Gold Refining Company, of which D. A. Corcoran is president, started operating its plant last month. W. E. Netherlin is superintendent. Caravan Refining Company, formerly the old Home Refining Company, Red Seal Refining Company and the Electrol Refining Company comprise the remainder of the plants in this area.

Deer Oil Corporation Formed

Deer Oil Corporation has been organized to take over the Luling and Brownwood, Texas, refineries formerly operated by Central Texas Refining Company. T. J. Mullin, president of Cranfill-Reynolds Pipe Line Company, a Moody-Seagraves enterprise, is chairman of the new company. Victor H. Smith, president of Gulf States Terman and Transport Company and affiliated companies, is president of Deer Oil Corporation. K. C. Woodruff, formerly general manager of Gulf States and White Oak companies is vice-president and general manager of the new company. Ray Uhlman is in charge of sales. General offices are on the seventh floor of the Esperson building, Houston, and the fourteenth floor of the Hunt building, Tulsa.

Playa Del Rey Plant Operating

Del Rey Oil & Refining Company has completed construction and is operating its new natural gasoline plant on Union Oil Company's lease in the southwestern portion of the Playa del Rey oil field near Venice, California. The plant handles 15,000,000 feet of gas daily and is designed for the addition of more units as needed.

Edeleanu Units

Edeleanu process units are being installed at this time in five refineries. At the Wilmington, California, refinery of Union Oil Company, an additional unit is being installed for the treatment of kerosene by this sulfur dioxide extraction process. Two plants are under construction for Anglo-Persian Oil Company, one at Abadan, Persia, and one at Grangenouth, Scotland. Anglo-Mexican Petroleum Company is installing a new unit at its Minatitlan, Mexico plant, and a second unit is being assembled at the Palembang, Sumatra, refinery of Standard Oil Company of New Jersey.

New California Refinery

General Petroleum Corporation is said to have tentative plans under way for a new refinery at Torrance, California, where the company has a tract of 300 acres. The plant will consist of the main refinery unit and a group of operating structures consisting of boiler house, pumping station, machine shop, and other mechanical buildings. Extensive storage facilities will be provided. The entire project is reported to cost about $8,000,000 including machinery, according to News Edition, Industrial and Engineering Chemistry.

Small Plant at Corpus Christi

Houston Oil Company has started operating a small refinery of about 300 barrels capacity on its tract at Violet, near Corpus Christi, Texas. This preliminary plant is for the purpose of supplying local demand. It is expected that the company will let contract in the near future for the construction of a 10,000-barrel plant at this point. W. R. Hounsell, formerly at the company refinery at El Dorado, Arkansas, is in charge of the work at Corpus Christi.

Abandon McMillan Plant

McMillan Petroleum Corporation has shut down and is abandoning its refinery in El Dorado with the opening of its new refinery at Norphlet. Some equipment from the old refinery will be used in the new project.

Refineries Shut Down

Mid-Kansas Oil & Gas Company, which was recently acquired through merger of Ohio Oil Company and Transcontinental Oil Company, September 1, shut down its three refineries for repairs. The Mid-Kansas organization took over the operation of the refineries on August 1. It is reported that the Fort Worth plant will resume operations within the next few days, but that the Boynton and Bristow, Oklahoma, plants will remain inactive for some time. Improvements are announced at all plants.

Peerless Oil & Refining Company which has been thrown into receivership, C. O. Nelson, receiver, has shut down its refinery at Chanute, Kansas.

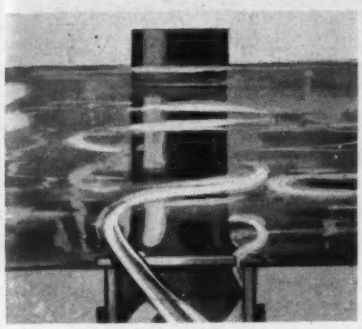
Empire Oil & Refining Company (Cities Service) has shut down its Cushing, Oklahoma, refinery for an indefinite period. At the same time the Ponca City plant has been enlarged to a rated capacity of 12,000 barrels.

New California Refinery

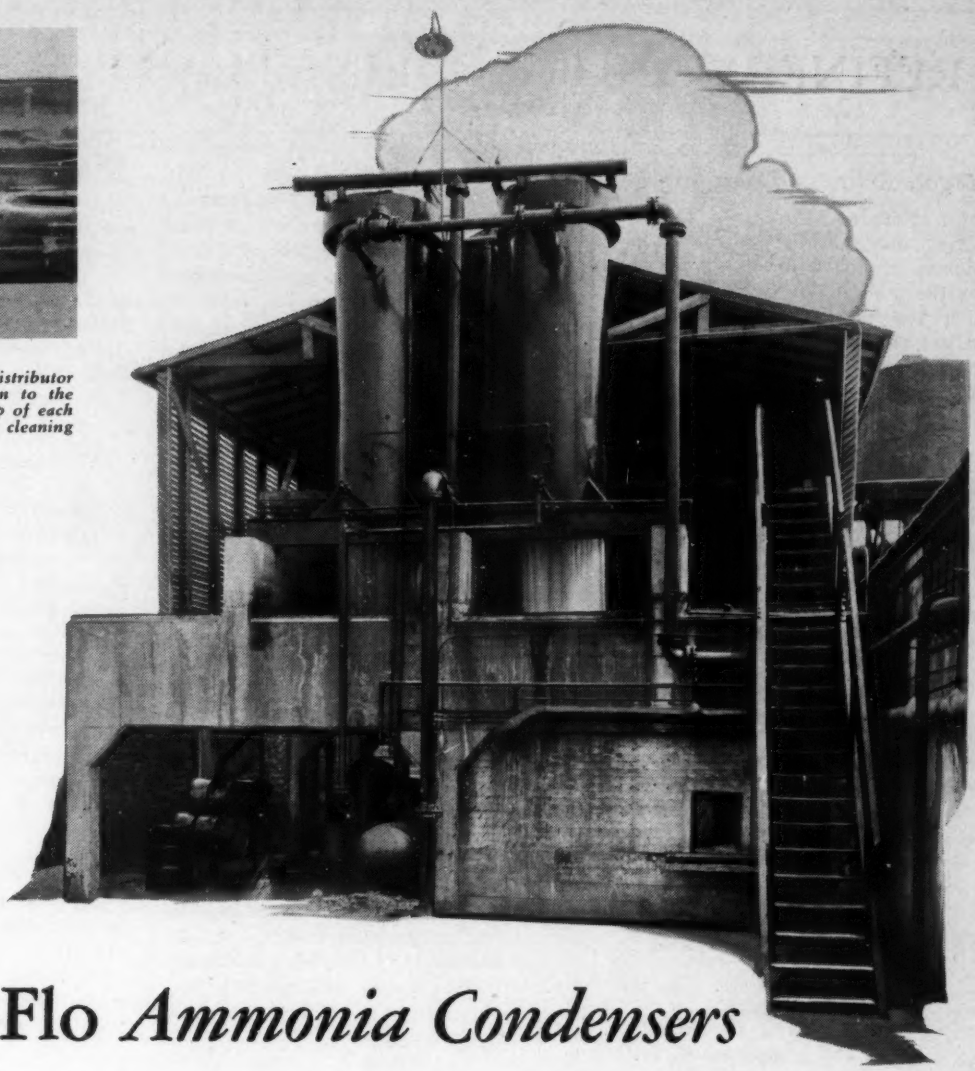
Mohawk Petroleum Company is building a 4000-barrel skimming plant near the Venice (Playa del Rey) field. Construction is being rushed to completion and the plant should be in operation within the next month. Reports state the company plans purchasing or building its own retail outlets.

Enlarge Olney, Texas, Refinery

Olney Refining Company, Olney, Texas, Young County, is making repairs and enlarging capacity through the addition of a new tube still unit. Reece S. Allen and associates of Wichita Falls recently purchased the plant from C. T. Anderson and S. J. Marcell, who erected the first unit in 1924 to operate on Archer and Young County crudes.



The Carbondale Spira-Flo distributor which imparts a swirling motion to the cooling water; inserted in the top of each tube and readily removed for cleaning purposes.



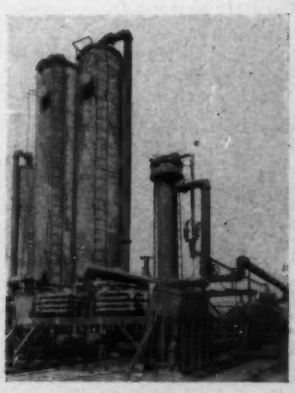
Efficient Spira-Flo *Ammonia Condensers*

Through each condenser tube for its entire length the swirling stream of water is in contact with the tube. That is why Spira-Flo Condensers produce maximum effect and bring the head pressure closer to the limits set by the outlet water temperature.

Spira-Flo Condensers used with Carbondale Systems provide the desired refrigeration for low cold test oils. Minus 40° F and lower as needed, in any capacity is being obtained by many leading manufacturers.

The cooperation of Carbondale Engineers, whose knowledge is seasoned by many years of service to refiners, is freely offered.

THE CARBONDALE MACHINE CO., CARBONDALE, PA.
Branches in principal cities



Carbondale Heat Exchanger installation.

Carbondale Refrigeration *for Refiners*

CARMACO

REFINERY AND GASOLINE PLANT ACTIVITIES

Paragon Refinery Enlarging

Paragon Refining Company (Union Gulf Corporation subsidiary—Gulf Refining Company group) will enlarge the refinery by the addition of two 9000-barrel tube stills and fractionating equipment. Late reports state that Paragon Refining Company assets will be sold to Gulf Oil Corporation on September 12 for approximately $10,000,000 and that this does not include cash, notes, and accounts receivable and majority stock of Valvoline Oil Company (operating two refineries in Pennsylvania).

Oklahoma City Refinery

Peveto & Peacock Refining Company plans to have its refinery at Oklahoma City in operation early in September as was reported in these columns two months ago when the company was moving most of the equipment from an old plant at Russell, Kansas. A Winkler & Koch pipe still and fractionating facilities have been erected. J. L. Shoemaker, formerly of Shell Oil Company of California, is superintendent. The company address is 2307 North Lottie street.

Phillips-Independent Merger

Phillips Petroleum Company and Independent Oil & Gas Company are to consolidate. This will bring the total refining capacity of the company to 24,000 barrels daily with refineries at Okmulgee, Oklahoma, Kansas City, Kansas and Borger, Texas. Phillips Petroleum Company is the largest manufacturer of natural gasoline. The announcement states that no change in headquarters or personnel of either company is contemplated. (See page 54).

Pure to Build Plant at Toledo

Pure Oil Company has announced plans for the immediate construction of a 6000-barrel plant at Toledo, Ohio, to be located along the Toledo harbor. Gyro Vapor Phase cracking units will be installed at this plant. Crude will be brought from the company's producing properties in Michigan. Estimated cost is $2,500,000. This is the seventh refinery for Pure Oil Company and its first plant in the Great Lakes region. The company's other refineries are located at Ardmore and Muskogee, Oklahoma, Nederland, Texas, Marcuss Hook, Pennsylvania, Heath (Newark), Ohio, and Cabin Creek, West Virginia. (See page 60).

Van Plant Nears Completion

Pure Oil Company is scheduled to have a few units of its Van field compression gasoline plant in operation early in September. Pure Oil News states:

"Construction work on the Van gasoline plant, which is being built one mile north of the town of Van, was started July 15. Plans call for a 14-unit plant. All the blocks have been poured and 13 Bessemers are in place. About one-half of the compressors piping has been installed. The other Bessemer will be sent down from one of the Oklahoma plants as soon as the plant can be converted from absorption to the compressor system. The two type 80 Twin Coopers have been installed. Work on connecting them up to the two A. C. 156 K.V.A General Electric generators, which will furnish electrical current for the plant is practically completed. All of the Bessemer compressor units were transferred from plants 15, 16 and 18 and the Thomas and Aldridge air plant in Oklahoma. Erection of the Braun cooling tower has been started.

W. L. McCarty is assisted in the erection of the plant by B. A. Walker. O. W. Keener has charge of the civil engineering work. B. A. Murray is construction foreman. Roy Douglas is in charge of the clerical work."

Sunray Adds Unit

Sunray Oil Company at its Allen, Oklahoma, refinery will double capacity from 3000 barrels to 6000 barrels through the addition of a tube still unit for crude distillation. The unit is being supplied by Southwestern Engineering Company. This plant was operated as Homaokla Oil Company until the recent acquisition of the company by Sunray Oil Company.

Teepee Building Refinery

Texas Pacific Coal & Oil Company, Fort Worth, is contemplating the erection of a refinery at Temple, Texas, that will have a capacity of about 3000 barrels daily, as result of the company having recently expanded in its wholesale and retail gasoline business in the south central part of the state. The company has a prolific lease in the Hobbs field, New Mexico, and arrangements can be made to deliver this production to Temple at a nominal transportation cost by using the common carrier service offered by Atlantic Pipe Line Company.

Alberta Tar Sands Hydrogenated

University of Alberta (Canada) and the Alberta Research Council have announced that through the researches of E. H. Boomer and A. W. Saddington, it has been established that bitumen from the Alberta tar sands, hydrogenated at high temperature and pressures will form a light crude oil amounting under favorable conditions to 80 per cent or more of the original bitumen. Optimim temperature was around 380°C. (716°F.), and the best catalysts used were ammonium molybdate and ammonium chloride. An absorption of hydrogen equivalent to three per cent by weight of bitumen was easily obtained. The oil had a sulphur content equal to about one-half of that of the bitumen; it is easily refined to produce a stable white gasoline. (See Refiner and Natural Gasoline Manufacturer, issues of August and September, 1930—Hydrogenation of Mineral Oils, by I. N. Beall).

Vacuum Acquires White Star

Vacuum Oil Company has acquired White Star Refining Company which operates a 6000-barrel refinery at Trenton, Michigan, and a 5000-barrel plant at Wood River, Illinois. The acquired company will continue to operate as a separate unit under its established name, just as was the policy upon completion of the acquisition by Vacuum of Lubrite Refining Corporation at St. Louis. The buying organization also announced that negotiations would soon be completed whereby a similar large company would be acquired. Reports state that this concerns the deal between Vacuum and Wadhams Oil Company-Bartles-Maguire Oil Company concern which is operated by a holding company and has a refinery at East Chicago of cracking type. Two concerns of similar size in Texas are reported dickering with Vacuum Oil Company. (See page 58).

Vacuum Installs Vapor Phase at St. Louis

Vacuum Oil Company, through its subsidiary, Lubrite Refining Corporation, operating refinery at East St. Louis, Illinois, is adding to its vapor phase cracking facilities at that plant through the installation of two 1250-barrel units of the Pratt vapor phase cracking process. The first of the Pratt units has been in operation at this plant for several months.

J. P. Devine Manufacturing Company, headed by Charles P. Devine, has purchased the manufacturing and sales rights of the Pratt vapor phase process. C. J. Pratt, originator of the process, will remain president of the Automotive Distillate Corporation.

Lube Plant Added

White Oak Refining Company is adding new lubricating oil manufacturing equipment at its Allen, Oklahoma, refinery. Earl Petty, formerly southwestern manager for Smith Engineering Company has been appointed assistant to Victor H. Smith, in charge of refineries, pipe lines and terminals of the White Oak and affiliated companies. B. F. Green has been placed in charge of purchasing, accounting, insurance and taxes of the group of companies.

New Equipment for the Modern Plant

New Pressure Tank Design

CHICAGO BRIDGE & IRON WORKS

Chicago Bridge & Iron Works has developed a new type of oil tank for the storage of volatile liquids under pressure. It is called The Hortonspheroid because of its unusual spheroidal shape.

The Hortonspheroid was designed to provide storage, which will withstand internal pressure, in large units at a more economical cost than the type of containers which have been used in the past for pressure storage.

An analysis of the construction of ordinary pressure tanks shows that a considerable amount of material is used primarily to maintain the shape of the container. Therefore, in order to secure a more economical type of structure it was necessary to design a tank in which all material is used for a direct purpose.

The tank was designed as nearly as possible to the shape which a flexible container such as a rubber balloon, would take when filled with water, subjected to an internal gas pressure and placed on a flat surface.

In the spheroidal design of tank, the bottom, shell and roof form a more or less continuous curve. A considerable amount of the bursting force is transferred to the roof and bottom and all of the metal is used for effective stress purposes.

The spheroidal shape is used to meet the conditions encountered with various combinations of liquid pressure. Increasing the gas pressure tends to make the structure more spherical and increasing the liquid tends to flatten it out. The only place where the tendency of the structure to change shape is sufficient to require reinforcing is a section near the bottom. Here supports are placed to take care of the overhanging liquid load.

Natural gasoline, high test and even some ordinary motor fuel gasolines boil at normal temperatures. When boiling takes place, the liquid is changing to a vapor throughout the entire body of the liquid and evaporation loss is excessive unless the container in which such products are stored will withstand pressure. The Hortonspheroid will be used for this type of products.

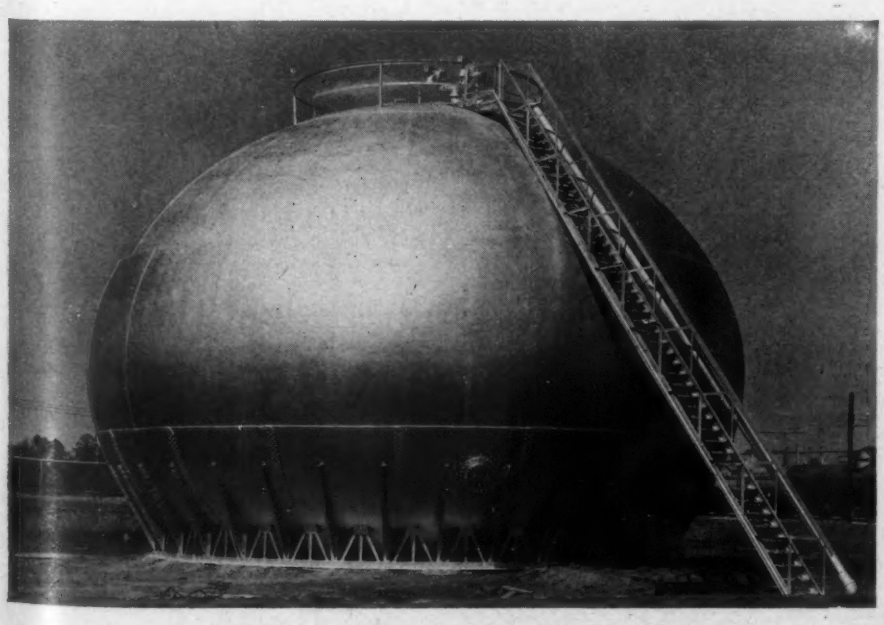
An experimental installation was made in June, 1928, in Chicago. It is designed for a working pressure of five pounds and has a capacity of 10,000 barrels. This structure was first built without stiffeners of any kind and subjected to structural tests.

With no liquid in the Hortonspheroid, compressed air was put in and the pressure increased gradually until a vertical buckle appeared in the lower portion of the shell. Then the pressure was relieved and liquid load alone applied until a horizontal buckle appeared around the circumference just above the ground level.

Observations made during these tests indicated the stiffening necessary and a girder was placed around the base of the structure. It was then filled with water and five pounds pressure applied and relieved 500 times, or the equivalent to over a year's service.

The experimental Hortonspheroid was filled to within about two feet of the top with water on September 8, 1928, and 700 gallons of gasoline pumped on top of the water. The Hortonspheroid was closed and a continuous record kept from September 8 to October 20 of the changes in pressure by means of a recording gauge. The internal pressure never exceeded five pounds, indicating no evaporation loss from the vent which was set to open at that pressure.

Five commercial installations have already been made, four of which are 10,000 barrel capacity.

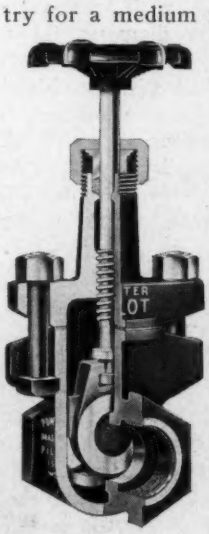


The Hortonspheroid at Phillips Houston Plant

Gate Valve

WILLIAM POWELL COMPANY

William Powell Company's new "Master Pilot" gate valve was designed to meet a specific need in the oil industry for a medium pressure moderately priced gate valve in small sizes. Its construction offers equally good service when used on steam, air, water, oil and gas lines.



"Master Pilot" gate valves are made in sizes ¼-inch to 3-inch with screw ends, and in sizes 1-inch to 3-inch with flanged ends. Sizes ¼-inch to 2-inch are designed for working steam pressures to 150 pounds at 450° F. total temperature, and 225 pounds water, air, oil or gas working pressures at 100° F. Sizes 2½-inch and 3-inch are designed for 125 pounds working steam pressure at 450° F. or 175 pounds water, air, oil or gas working pressures at 100° F.

"Master Pilot" gate valves are furnished with high grade cast iron bodies and bonnets. The stems, packing nuts, and discs are made from steam bronze. For handling liquids and gases destructive to copper alloys the packing nuts

and discs can be supplied of iron and the stems of steel. Valve bodies are made with heavy wall thickness and full way openings. Seat faces are large and wide, and accurately ground to insure proper alignment with the discs.

Two heavy lugs are cast on the bodies and are so arranged to slip in and firmly hold head of proper size standard bolts for binding bodies and bonnets together. This construction affords ease in replacement of bolt in case of accidental burring of threads, which is not the case with the usual "U" type bolting arrangement. A gasket face is machined on the bodies and bonnets for tightly holding leak-proof gaskets.

The bonnets are supplied with full acme thread, accurately machined. A large packing chamber is arranged in top of the bonnet, allowing plenty of packing with gland follower. Heavy packing nuts are supplied for properly compressing gland followers on packing. Two through bolt holes are drilled in sturdy lugs on either side of the bonnets, which engage with bolts set in body. Special gaskets are supplied for oil, gas and gasoline, or air, steam and water service.

Handwheels of the non-heating type are of malleable iron, with knob ends and large enough in diameter for a firm grip.

Stems are furnished with machined full acme threads, the unusual length of which assures unlimited wear. A pack-under-pressure collar is machined on the lower part of the stem, which allows the valve to be packed under pressure when full open.

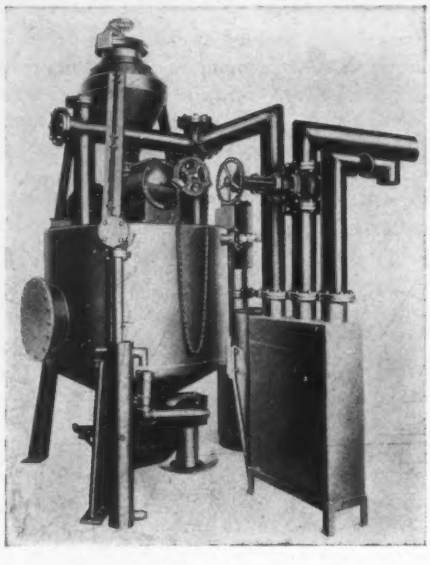
Acetylene Generator

OXWELD ACETYLENE COMPANY

Oxweld Acetylene Company, 30 East 42nd Street, New York, has placed on the market two improved types of non-automatic stationary acetylene generators for supplying large volumes of acetylene. These generators are each made in two sizes having 500 and 1000 pounds carbide capacity. They are designed for large industrial plants where oxwelding and cutting are used extensively and where oxygen and acetylene are piped to stations convenient to operators.

The Oxweld Type NA-3 acetylene generator, shown in the illustration, is for plants using low-pressure welding and cutting apparatus and delivers to a storage holder which is weighed to supply acetylene to the shop piping system at a pressure of 20-inch water column.

In operation, the carbide is conveyed from the hopper to the generating chamber by a rotary feed screw driven by a slow speed reciprocating water motor. The screw, being cast nickel, is very resistant to wear and will not cause sparks.



Oxweld Type NA-3 Acetylene Generator

From the generator the gas enters the wash box where it passes through a water seal which acts as a scrubber to remove any particles of residue which might have been carried over. This device supplants the felt or hair filter usually employed. It has the advantage that it cannot clog and cause abnormal back pressure or insufficient delivery to the holder. It thus insures a constant generating pressure.

When residue is being drawn off from the generator the wash box acts as a vacuum release and permits a reverse flow of gas which allows acetylene to return from the holder to the generating chamber to displace the drained water. When the generator is refilled with water, the gas passes from the generating chamber to the holder through this same wash box. The wash box is provided with an overflow which automatically limits the water level to give proper depth to the seal and to permit the functioning of the vacuum release during recharging.

The gas holder of suitable size may be located either inside or outside the generator house as best meets the needs of the particular installation. On the holder is mounted an automatic water holder shut-off which stops the carbide feed mechanism. When the gas bell approaches its upper limit, this shut-off must be opened by the attendant before the generator will again produce acetylene.

Except for this one automatic feature, all operations having to do with the starting and stopping of carbide feed must be performed by the generator attendant. For this reason, the generator is classed as non-automatic, that is, the carbide feed is not automatically governed by, or interlocked with the immediate acetylene requirement.

Gas-Liquid Meter

THE MERIAM COMPANY

The Meriam Company, Cleveland, has designed a new instrument of the U-tube type for the purpose of indicating simultaneously the line pressure and rate of flow of liquids or gases in pipe lines. This instrument supersedes the combination type that was on the market last year. The old instrument was very satisfactory but it was necessary to change certain operating features, involving a matter of only a few seconds, in order to get both pressure and rate of flow.

The new instrument is of entirely different construction and uses two liquids instead of one. Red oil and water are ordinarily used unless it is necessary to use heavier or lighter liquids to accord the pressure and flow to be dealt with. Bulbs on the two outer ends have openings which are connected to the pipe line in the same way as the ends of the old flow meter. A riser tube, of a height proportionate to the line pressure to be measured and to the liquid to be used, is connected to the middle point of the "W," the shape of the new instrument.

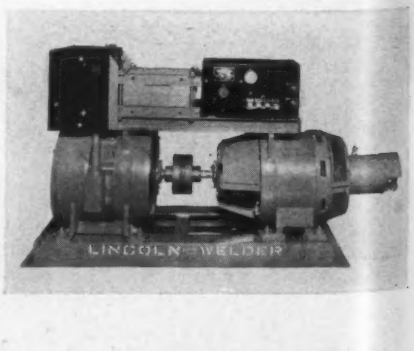
Operation of the instrument consists of pouring the heavier liquid into each of the "V" tubes and then pouring the lighter liquid into the riser tube so as to act as a seal. This addition will make the levels of the heavier liquid unequal and sufficient quantity of the lighter liquid is added at the bulb ends to correct this. The instrument is then installed on the pipe line.

New, Larger Welder

LINCOLN ELECTRIC COMPANY

Lincoln Electric Company, manufacturers of "Stable-Arc" welders and "Linc-Weld" motors, announces placing on the market a new welder with a rating of 600 amperes.

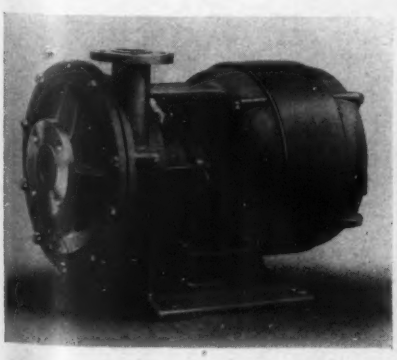
This new welder was developed as a result of a demand for higher welding



current to be used with large size metallic and carbon electrodes. This welder is also used to supply current for the "Electronic Tornado", a process of automatic carbon arc welding. The new welder may be had in either the portable truck type or stationary truck type. It is a motor driven, single operator, variable voltage machine and has a current range of from 180 to 750 amperes. The motor and generator are direct connected. The working mechanism of all controls are contained in a ventilated enclosed steel cabinet with hand regulators and switches mounted on a panel which forms a side of the cabinet. The control panel contains rheostat, diverter switch, safety starter switch, volt-ammeter and wing nut terminals for cables. This unified control greatly increases the simplicity of the operation of the welder. The control cabinet is mounted directly over the motor generator for easy access by the welding operator. This also permits the removal of the motor generator armature, without disturbing any other parts.

The use of a combined voltmeter and ammeter, known as a volt-ammeter, makes possible the reading of amount of voltage and amperage on one dial and eliminates the use of the separate delicate ammeter which would be given excessive wear on a Lincoln welder, due to the large output keeping the ammeter jammed against the high limit pin on the dial. In this way, the volt-ammeter insures longer instrument life. The face of the volt-ammeter is mounted flush with the control panel assuring the utmost protection possible.

Terminals for the lead cables are equipped with winged nuts, a feature which makes quick and easy connections possible, especially when it is desired to reverse the polarity of welding current. The use of these wing nut terminals also eliminates the necessity of a switch for reversing polarity.



Olivite Acid Pump

Acid Pump

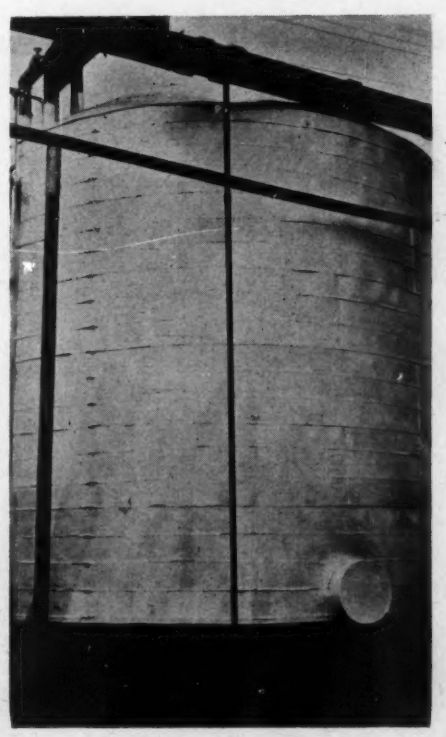
OLIVER UNITED FILTERS, INC.

Oliver United Filters, Inc., Oakland, California, and Hazleton, Pennsylvania, shows in Bulletin No. 301 a new 1¼-inch pump, motor drive, which has recently been added to this company's line. It is a centrifugal pump designed and built to withstand destructive action over long periods, with combined rugged construction with high hydraulic efficiency.

This Olivite pump is built to combat the problem of pumping mineral and organic acids and solutions of corrosive salts. This is accomplished by the use of Olivite for acid proofing the casing and impeller. In it is contained the chemical resistant qualities of hard rubber, but also containing a relatively high tensile strength. Olivite is vulcanized direct to the iron casing and impeller by a special process which insures a bond between the Olivite and metal at all temperatures and speeds.

Olivite pumps are now made in 1¼-inch and two-inch sizes, covering a range of capacities from 10 to 200 gallons per minute. The maximum head of the 1¼-inch pump is 60 feet and of the two-inch 100 feet at 1750 revolutions per minute. Intermediate heads are handled by modifying either the speed or impeller diameter to secure maximum efficiency.

Further details about this new pump may be had upon request.



Above is shown a tank which has been insulated with the special modern preparation of the "Save All" Insulation Company of Pittsburgh. The company, of which R. E. Zuker, engineer, is president, offers a service in sheet steel insulation work for tank protection with rock felt, an insulating material made especially for the company from pure argillaceous limestone, containing carbonate, magnesia, silica and alumina. This new product is manufactured in blanket form of various sizes, widths, thickness and length. The application recommended is on a basis of one and one-half inches for each 10 degrees below freezing and one inch in thickness for each 100 degrees of heat capacity.

Multi-V-Drive

WORTHINGTON PUMP & MACHINERY CORPORATION

Worthington Pump & Machinery Corporation, Harrison, New Jersey, has recently placed the Multi-V-Drive on the market. Developed in conjunction with the Goodyear Tire and Rubber Company after months of study and experimentation, this drive consists of a number of endless molded V-belts running in V-grooved sheaves. It combines a new long-life type of rubberized cord V-belt, impervious to dust and moisture, with an improved V-grooved sheave.

The Goodyear emerald cord belts used in the Worthington Multi-V-Drive combine, in the correct ratio, high power capacity, low stretch and accurate cross-section. The load-carrying members are high-grade cotton cords arranged in parallel lines and concentrated about the neutral axis. The design is such that each belt in the Multi-V-Drive takes an equal share of the transmitted load.

Each sheave is grooved, machined and finished so that the grooves present a smooth surface on which the belts run. The wedging action between the belts and the grooves results in a slipless, powerful grip which compensates for, but differs from, initial belt tension in a flat belt drive.

The smooth-grooved construction of this drive, together with the fact that there is an exact mathematical relationship between the grooves and the molded shape of the V-belts, offers an effective conformity of the belt to sheave to give maximum power transmission efficiency.

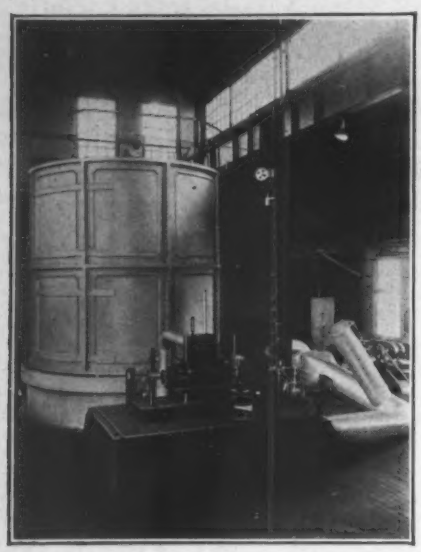
Gas Meter Prover

CONNERSVILLE BOILER COMPANY

Connersville Blower Company, Inc., Connersville, Indiana, announces a dry type gas meter prover with a displacement of 2800 cubic feet per stroke, which has been erected and equipped in the laboratories of the company to be used for testing large gas meters of various types and designs.

Since the bottling of the wet type of prover is difficult for sizes larger than 20 cubic feet per stroke, and "strapping" or tape measurements for determining the diameter of the sheet metal bells will give only average dimensions, the dry type was selected for this

larger capacity prover. The cylinder was accurately bored on a boring mill, and the piston turned to fit. With these parts formed with machine tool precision, much greater accuracy is possible in determining the displacement. The absence of water also eliminates water vapor complications, which sometimes arise in the wet type prover testing.



In designing and equipping this 2800 cubic feet prover, the company has been assisted by suggestions from engineers of the Bureau of Standards and also of the gas industry.

This prover consists of a cast iron cylinder having an inside diameter of 16 feet and a height of 16 feet above the top of the foundation, with a closely fitted cast iron piston that is raised and lowered within the cylinder by a hydraulic plunger, and electrical means for recording the stroke. Auxiliary equipment includes a motor driven Cycloidal rotary pump, which produces the 225 pound hydraulic pressure for raising and lowering the piston; a small oil pump, driven by air motor, which supplies oil to seal the 16 ft. diameter piston packing, so there can be no leakage; a motor driven fan that furnishes air to operate the meters before the piston is started on its downward stroke; a radiator, located at the inlet to the fan, through which water is circulated to maintain an even air temperature; and a switchboard for operating the various motor driven auxiliaries.

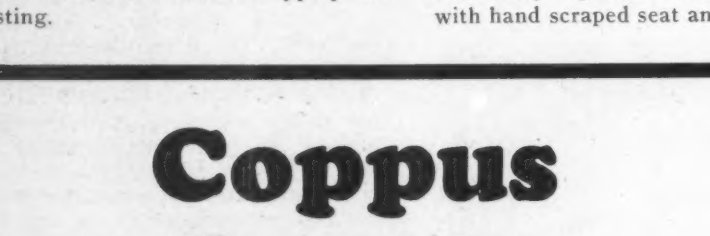
The prover is controlled by a hydraulically operated rotary air valve with hand scraped seat and a hydraulically controlled gate valve for raising and lowering the piston. The opening and closing of the air valve and water valves which regulate the rate of piston fall are synchronized by four-way automatically operated pilot valves.

Electrical contractors synchronize the readings at the meter with those of the prover. Indicating thermometers and pressure gauges are used to show the condition of the air in the prover and at the meter.

While erected primarily to show the accuracy of Connersville meters, this prover is available to gas companies, public service commissions and others, who may require these facilities.

American Rolling Mill Company, Middletown, Ohio, has published a bulletin titled "Better Welds with Armco Ingot Iron." The quality of this product as a welding material is told, and illustrations of actual jobs are given. The bulletin covers 40 pages in which the story of Armco ingot iron is told; and the 35 years of service of the company is depicted. All of the information necessary on the material, uses in welding and methods are covered in description and charts in this bulletin, which may be had for the asking.

Coppus Steam Turbines



Horizontal Vertical

1/4 to 60 H.P.

Explosion proof . . . Easy speed control . . . Rugged, reliable and low priced . . . Best steam economy, giving power without cost when used as 'reducing valve' for heating or process work . . . Exhaust steam free from oil.

Read bulletin 135

Coppus Engineering Corporation
360 Park Ave., Worcester, Mass.

TUBE-TURNS

Sizes: 16" down to and including 1"
180°, 90° and 45° angles
In Warehouse Stock

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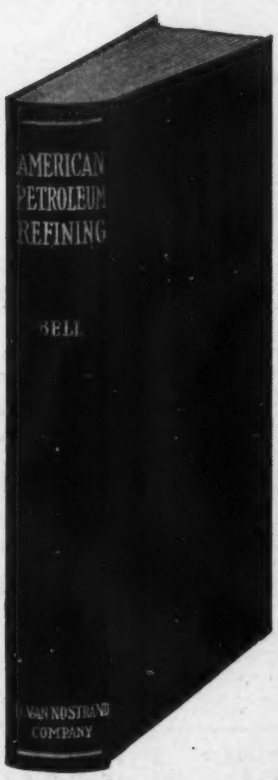
American Petroleum Refining

By H. S. BELL, C. E.

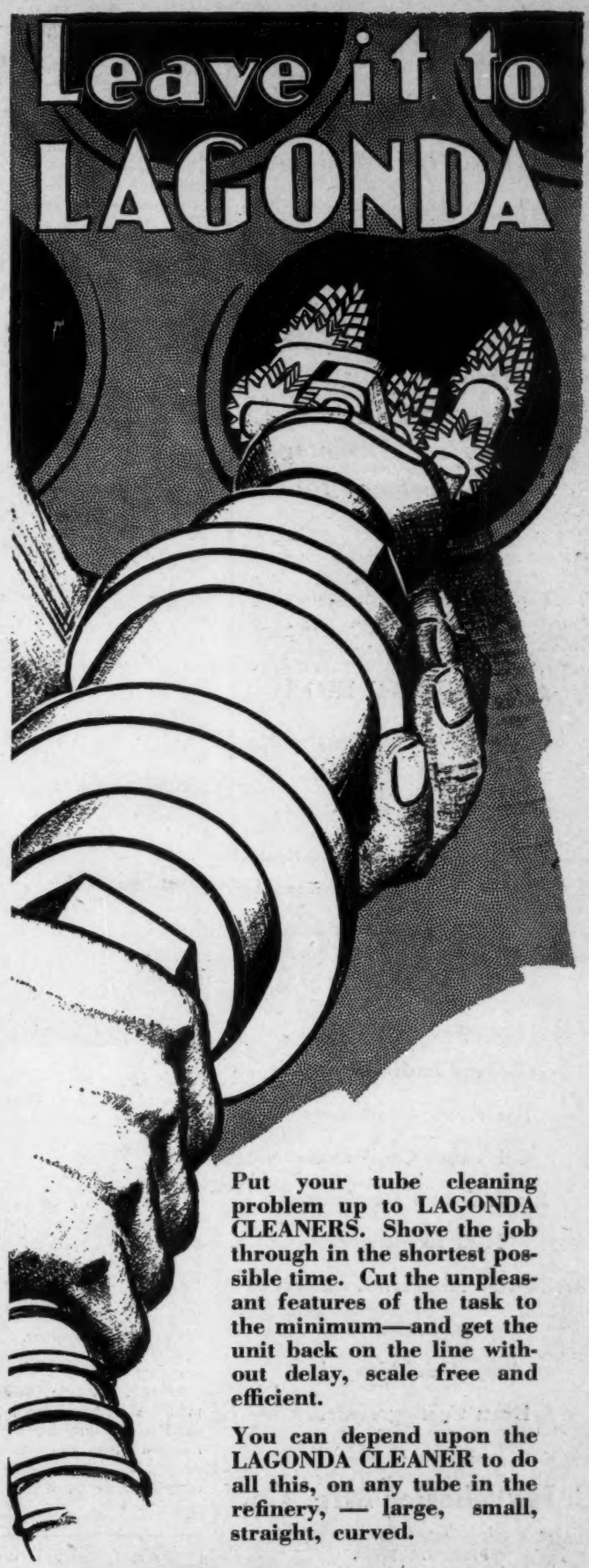


Every detail of American refinery practice — the most up-to-date developments as well as the standard methods — are fully covered in this book. Vapor phase craking, the production of high compression gasoline, the development of modern pipe stills, the use of Diesel engines in oil pumping, and hundreds of other subjects of equal interest and importance, are discussed, covering in full every detail of oil refinery operation, engineering, and design.

630 pages, Buckrom, 6x9, illustrated Postpaid $6.00

Send Order to

THE GULF PUBLISHING CO.,
P. O. Box 1307, Houston, Texas



Put your tube cleaning problem up to LAGONDA CLEANERS. Shove the job through in the shortest possible time. Cut the unpleasant features of the task to the minimum—and get the unit back on the line without delay, scale free and efficient.

You can depend upon the LAGONDA CLEANER to do all this, on any tube in the refinery, — large, small, straight, curved.

The Lagonda Mfg. Co.
SPRINGFIELD, OHIO
FUEL SAVING SPECIALISTS
NEW YORK, CHICAGO, PHILADELPHIA, BOSTON, PITTSBURGH, CLEVELAND, CINCINNATI, DETROIT, SYRACUSE, BALTIMORE, ATLANTA, SAN FRANCISCO, MONTREAL, LONDON, ST. LOUIS, KANSAS CITY, DENVER, DALLAS,

Talking Points are Talking Points But—

When hundreds of firms, on *Job* after *Job*, YEAR after YEAR—continue to use ANY one product—

It Must Have Advantages of Importance to You, Too.

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Surface Condensers
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ITEMS ABOUT MANUFACTURERS

Leeds & Northrup Company, 4901 Stenton avenue, Philadelphia, has issued Bulletin No. 880, describing the company's relative humidity recorder, a new departure in recording humidity. The unique feature of the instrument is that it records relative humidity directly. The manner in which this is accomplished is explained in the bulletin, a copy of which is available upon request to the address given here.

Catalog No. 90, of Leeds & Northrup Company, entitled "The Hump Method for Heat Treatment of Steel," 1930 issue, is similar to the last edition except that it contains on pages 10 and 11 a presentation of the problem of control of the rate of heating above the critical with the same precision as below it. The discussion of this problem is followed on pages 15, 16 and 17 with an outline of its solution through the use of the company's automatic rate control as applied to the Hump method of hardening. This catalog, too, is available by writing the company's home office.

Lincoln Electric Company, Cleveland, has published for persons interested in welding a catalog on automatic arc welding by the electronic tornado process, which in 40 pages of description, illustrations and charts, gives a complete analysis of this method of welding.

Quigley Furnace Specialties Company announces a change in the name of the company to Quigley Company, Inc., owing to the rapid and broad development of their products during the last few years.

Originally this company dealt in furnace specialties only, but in recent years has engaged in the manufacture and marketing of a number of additional products.

While the company will continue to manufacture Hytempite on a bigger scale than ever, they have added other products, several of which are not related to furnace operation.

The products now include: Hytempite, high temperature cement; Q-Chrome, a neutral base refractory cement; Acid proof cement, for acid resisting masonry; Ganisand, a granular refractory; Quigley gun, for shooting refractory and concrete mixtures; Triple-A protective coatings for metal, concrete, stucco, wood, etc.; Q-Seal, a plastic, expansive, joint-sealing compound and Annite, an all purpose cleaning compound. The main office of Quigley Company is at 56 West 45 Street, New York City, with distributors in 90 cities throughout the United States and at 35 foreign points.

Bullard Davis, Inc., subsidiary of Davis Emergency Equipment Company, 67 Wall Street, New York City, has recently completed

This is an interior view of the new manufacturing plant at Oklahoma City of American Tank and Equipment Corporation. Latest machinery has been installed for designing and making refinery and natural gasoline plant equipment of all kinds. The company is a subsidiary of Black, Sivalls and Bryson, Inc., who are selling agents for American Tank and Equipment Corporation

Electrically Driven Centrifuges
Hand Centrifuges
WRITE
WILLIAMS, BROWN & EARLE, Inc.
Manufacturers of Laboratory Apparatus
918 Chestnut St. Philadelphia, Pa.

Ljungström AIR PREHEATER
CONTINUOUS REGENERATIVE COUNTERFLOW
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AIR PREHEATER CORPORATION
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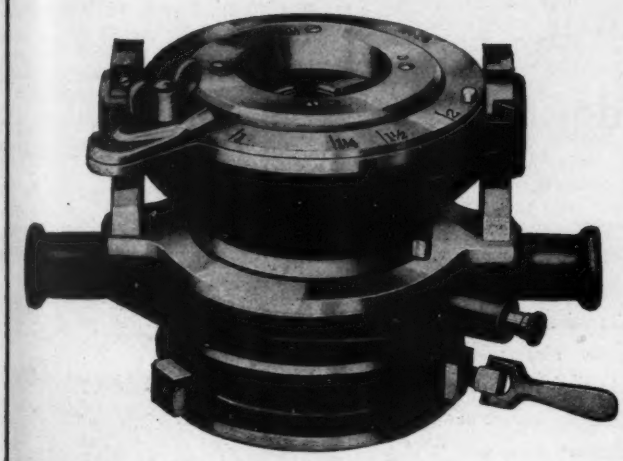
No. 26 Beaver Ratchet 1"-2" A "HEAVY DUTY" Die Stock



An Extra-Heavy Tool For Extra-Hard Usage

If you were to make a check throughout the oil fields of the world—in California, in the Mid-Continent, Wyoming, Venezuela or Russia—you would find the No. 26 (1" to 2") Beaver Die Stock is used almost exclusively.

There are a number of sound reasons for this!

FIRST—The tool is fully self-contained — there are no loose bushings or extra dies to bother with. It is a "one-piece" tool.

SECOND—It is heavy, strong and rugged—and will stand a tremendous amount of abuse.

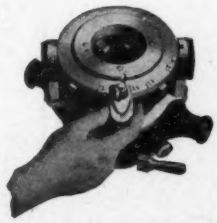
Several years ago the Nos. 25 (plain) and 26 (ratchet) were discontinued—in favor of the new Nos. 11 and 11-A, which are lightweight, self-contained tools.

However, so insistent has been the demand, not only from the oil and gas companies the world over, but from hundreds of plumbers and steamfitters, that we have been forced to again make these tools available.

Write for Bulletin C-2.

Self-contained
Adjustable
Durable
Strong

The Universal Chuck centers the pipe accurately—no loose bushings.



Set it to size—that's all. One set of dies threads all sizes.

Other Types of 1 to 2" Beavers

If you prefer the "self-contained" feature but your work does not quire heavy-duty tools, the light-weight self-contained 1 to 2 Beavers (Nos. 11 and 11-A) will appeal to you. Ask for Bulletin C.

If you prefer the four-post "separate-die" type of 1 to 2 inch die stock then Nos. 8 and 8R Beavers (with nine distinct advantages) will more than appeal to you. Ask for Bulletin C-1.

THE BORDEN CO., 518 Dana Ave., Warren, O.

Die Stocks
Groovers

BEAVER

Pipe Cutters
Power Units

Read this!

TWO hundred thousand dollars a year saved around a refinery is an item worth entering on anybody's books. That is the savings on material, that would otherwise have to be written off as junk, credited in 1929 to the reclamation department of the

Note: If you haven't a copy of National Petroleum News for April 2nd in which this article appeared, we will gladly send you a reprint. Just drop us a card.

AND one of the essential features of this unusual saving was the use of Oakite in removing oil, grease and dirt from valves, fittings, pipes, meters, rags and other discarded equipment before repair. Would a saving of $200,000 or even $2,000 look good on your books? This proves it CAN BE DONE! Let us show you how Oakite will help, by speedy, thorough, economical cleaning, without scrubbing or scraping, without danger. Write for the details now!

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Oakite Service Men, cleaning specialists, are located at

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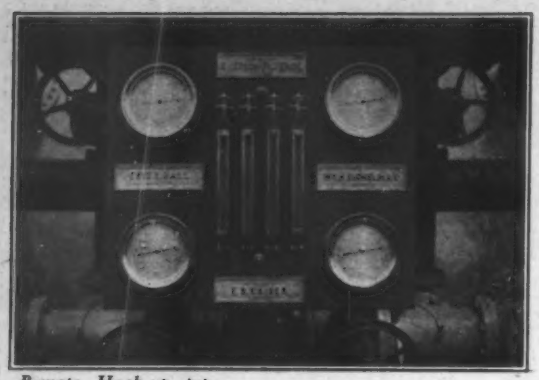
***Stocks of Oakite materials are carried in these cities.**

OAKITE

TRADE MARK REG. U.S. PAT. OFF.

Industrial Cleaning Materials and Methods



Remote Hook-up type mounted on panel board.

Easier to read . . .

Accurate!

Dependable!

Whether it is a Remote or Close Hook-up type the M. J. L. Flow Indicator is easy to read. You read it directly—in any units desired for flow of gases, oils, water, air, steam or chemicals. Regardless of the condition of flow, constant or variable, the M. J. L. Flow Indicator maintains positive accuracy. Handles pressure up to 2000 lbs. Refineries throughout the world are installing M. J. L. Flow Indicators due to their dependableness. These indicators require no maintenance expense. Order at your favorite supply house. Submit specifications to insure correct calibration. Write for folder.

MJL

MOREY & JONES, Ltd.

Manufacturing Engineers

924 Hemlock St. Los Angeles, Calif.

a catalog of gas protection equipment which is now ready for distribution.

This catalog contains valuable information on new equipment, including Davis Gas Masks, made of Red-D Rubber which offers a marked increased tendency to hold its shape, greater resistance to abrasion and remarkably longer life.

Davis ammonia masks and canisters are approved by the U. S. Bureau of Mines. Also included in this catalog is the Davis air line masks which are approved by the accident prevention committee of the American Gas Association.

The new ball bearing Air Line Mask Blower may now be operated with case either open or closed.

The Davis Inhalator used in conjunction with the prone pressure method of artificial respiration and approved by the American Gas Company and American Medical Associations, is also fully described.

Copies of this catalog will be sent free upon request.

GRANVILLE B. LANE

Granville B. Lane is now district manager for The Foxboro Company in Tulsa, having come from the factory to succeed J. B. McMahon, who is now located at the home office at Foxboro, Massachusetts.

Robinson Orifice Fitting Company, Los Angeles, has issued an attractive new catalog containing the latest data and specifications concerning the Robinson orifice fittings. While nearly 13,500 Robinson fittings are in service in the field and refinery today passing practical tests, it has been necessary to issue this catalog for reference by oil field and refinery engineers due to recent refinement of certain details in construction of the fittings. Working details of the different type Robinson fittings, together with sizes, specifications and prices are included in the catalog, as well as illustrations and description of the Robinson control valve.

Republic Steel Corporation recently placed into operation the first unit of its new $8,000,000 electric welding pipe mill. The mill involves the application of the Johnston electric weld tube patents to pipe of varying sizes, and many new features are involved in the product as well as the process.

The Fluor Corporation, Limited, Los Angeles, manufacturers of the Fluor redwood cooling towers, announce the opening of a new district office at 503 Fairfax building, Kansas City, with Guy T. Martin in charge. The firm also maintains branch offices in New York City, Tulsa, Dallas and Houston. Hugh B. Lamberth, manager of cooling tower sales, states that the opening of the new office

For cracking process in oil refineries we furnish Aluminum Armored Asbestos filled Gaskets and Corrugated Armco Iron or Monel Metal Asbestos encased.

Copper rings 3/16" thick for 4 and 5" O. D. tubing.

Washers or gaskets made of Aluminum, Copper and other Metals.

Write for Prices.

METALLO GASKET CO.

NEW BRUNSWICK, N. J.

-SPARKL-

Cleaner Saves Strength, Time and Money!

SPARKL, developed by expert chemists, is neither a soap nor a "scouring compound." It is an *improved* cleaner, scientifically correct and in a class by itself.

SPARKL is a solvent and a true detergent—a perfect cleanser. It "digs in," dissolves imbedded dirt and brings it out, so it will float away.

SPARKL *sterilizes* while it cleans, making premises sanitary. It's "The Modern Health Officer."

SPARKL works quickly—and *thoroughly*. It needs no "coaxing." You'll be amazed by the speed at which it makes metal, concrete, wood and other surfaces really CLEAN.

As evidence of SPARKL'S superiority, it has been standardized as a cleaner by many large oil companies, which demand the BEST.

SPARKL is Harmless

SPARKL, used as directed, will not harm paint or any surface or finish for which such cleaners are intended. This we guarantee.

You can buy small quantities of SPARKL for testing. Try it side by side with any other preparation. Compare the cost, the time and the RESULTS. That's all we ask.

Chemicals for Refiners and Natural Gasoline Manufacturers

Ward Chemical Corp.

TULSA, OKLAHOMA

Oklahoma City, Okla. Wichita Falls, Texas

TAYLOR

Seamless Forged Steel

BOILER NOZZLES

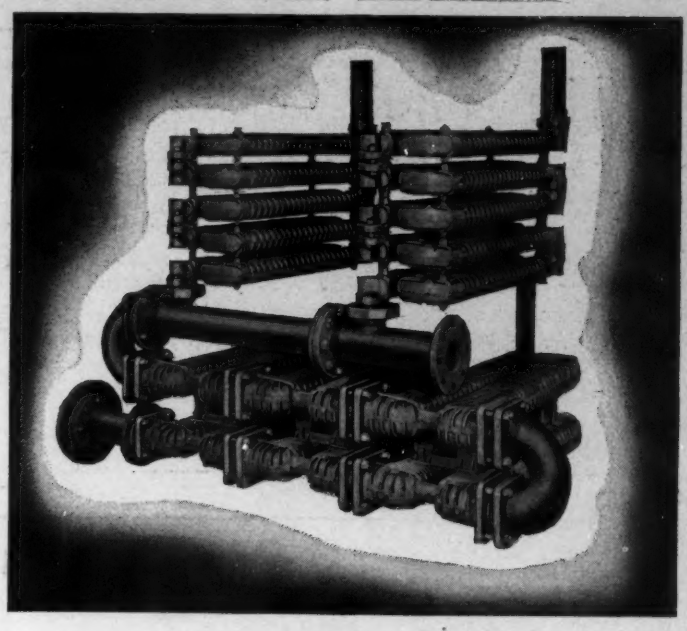
Used as outlets on oil stills, tanks and pressure vessels. Taylor nozzles are uniform in quality, assure absolute safety, and represent the highest development in seamless forging work. Readily available in sizes 1½" to 24" diameter, for all pressures.

Taylor nozzles are stocked in Tulsa by the Tulsa Boiler and Machinery Co., and in Los Angeles by the Midwest Piping and Supply Co.

Send for Bulletin 29-13

TAYLOR FORGE & PIPE WORKS, Chicago

Box 485, Chicago 50 Church St., New York



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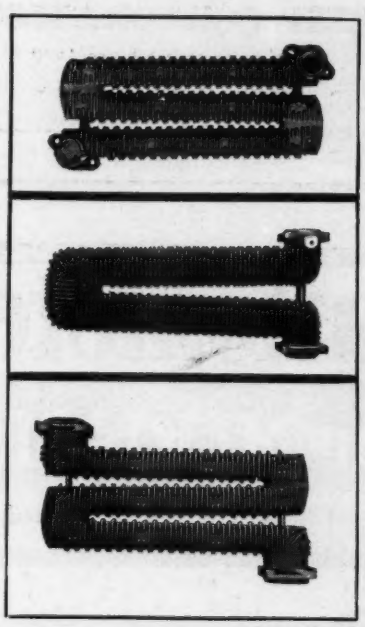
CONSTANT RENEWALS



When you install Sterling Condensing and Cooling Sections you are putting in insurance against frequent shut-downs for renewals.

Sterling equipment is manufactured from Arco Metal—a special alloy iron nickel chromium that resists corrosion. That is one of the reasons why so many refineries—large and small—have made it a standard.

Write for catalog—or better still, ask for one of our engineers to call and show you how Sterling Sections save money and increase efficiency.

FOR SALE BY THE NATIONAL SUPPLY COMPANIES

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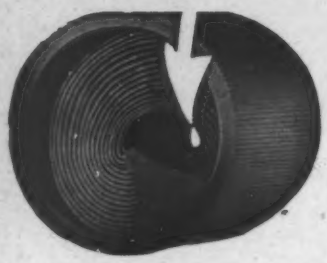
The Spiral Motion Is the Trick



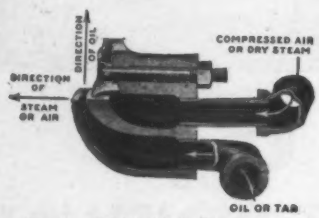
That's why Hood's Chemico Spiral Packing Rings have been selected by so many engineers. The center hole prevents choking and clogging.

Made of acid-resisting shale—practically indestructible.

Used by all big producers because of the intensive movements.

Samples on request

B. MIFFLIN HOOD CO., DAISY, TENN.



W. N. BEST High Pressure Oil Burner

W. N. BEST Oil Burners

are

dependable, efficient, economical, non-clogging atomizers of fuel oils, tars, acid sludges and still bottoms.

Write for catalogs.

W. N. BEST CORPORATION

Engineers and Manufacturers Since 1890

295 Fifth Avenue, New York City

Manometers

THE MERIAM CO.

1954 West 112th St., Cleveland, Ohio

NO FLOATS . . . NO THERMOSTATS . . . NO GENERATORS . . . NO MOVING PARTS

(Patented)

The Campbell Boiler Feed Water Regulator is guaranteed to maintain a constant water level regardless of load. It slows down the feed on sudden load increases; it quickly restores the water level when the steam demand decreases. Simple. Accurate. Dependable. Costs less to install and maintain than any other regulator. Any mechanic who can cut and fit pipe can install it. Let us tell you what it is doing in other refineries.

On which of these Atlas products do you want information?

- ☐ Feed Water Regulators
- ☐ Reducing Valves
- ☐ Damper Regulators
- ☐ Temperature Regulators
- ☐ Pump Governors
- ☐ Float Valves
- ☐ Swing Joint Fittings
- ☐ Bronze Unions
- ☐ Thermostats
- ☐ Balanced Valves

ATLAS VALVE CO., 275 South Street Newark, N. J.

Kansas City was made necessary by increased business in the Mid-West and has been established for the purpose of supervising construction work in that particular territory. In addition to redwood cooling towers, The Fluor Corporation specializes in the construction of compression plants, absorption plants, boiler installations, generators, concrete and pipe work and all kinds of heavy construction.

W. W. Patrick, a director of The Foxboro Company, died suddenly, July 11, of pneumonia. He was one of the most widely known figures in the instrument business. He had been associated with the founders of The Foxboro Company since 1899. In 1908 he became New York district sales manager and held that post for 22 years. He was also a prominent figure in the Association of Scientific Apparatus Makers of America. He was a director of the association and chairman of the industrial instrument section.

Maintenance Engineering Corporation, 1400-2 Conti street, Houston, has issued a new loose leaf catalog which is devoted to specifications and descriptions of refinery, pipe line and power plant specialties for temperature, pressure and piping, stocked in their Houston and Fort Worth warehouses. This catalog is made up from an engineering standpoint and contains valuable information on forged steel flanges, valves, fittings, etc., not otherwise readily available. Copies of this catalog will be mailed upon request.

Goetze Gasket & Packing Company, New Brunswick, New Jersey, has issued a 54-page catalog covering in description and illustration the complete line of gaskets manufactured by the company. A 10-page section is entirely pictorial, showing views of the company's plant and various types of the leading lines packed for shipment. Price, size and type tables are carried, covering every item featured by the company in this catalog. A copy is available by writing the manufacturer at the headquarters office, given above.

American District Steam Company, North Tonawanda, New York, has issued a 40-page catalog covering Adsco products for steam distribution, including steam line equipment, expansion points, casing, conduit, condensation and steam flow meters and other specialties for the economical distribution of steam. This is Catalog No. 30 of a series put out by this company on its line of equipment. It is replete with illustrations, charts and prices, and will be mailed upon request.

St. John X-Ray Service Corporation, 505 Fifth avenue, New York, has installed what is said to be the first X-Ray plant of its kind at the Barberton, Ohio, works of Babcock & Wilcox Company.

The photographic apparatus will be used primarily for routine inspection of welded seams in pressure vessels, heat exchangers and similar equipment.

Dr. Ancol St. John is president and technical director of the company which bears his name.

Worthington Pump & Machinery Corporation's Bulletin S-500-B2A, just off the press, is a pictorial bulletin for filing in loose-leaf form, and deals with the company's vertical four cycle air injection Diesel engine. Illustrations used throughout the 44 pages show every part of these Diesels separately, and also the engine built up and installed. The company's executive offices at 2 Park Avenue, New York City, will furnish a copy of this bulletin upon request.

CAUSTIC SODA
especially adapted for Oil Refining

When Michigan Alkali was founded, friendly, personal service helped establish the merits of Wyandotte Products. Today, though the company has grown far beyond the dreams of its founders, and the merit of its products is unquestioned, Michigan service retains its friendly, personal touch. Only the scope of the service is changed: it is now measured by the customer's need alone.

WYANDOTTE

"Distinguished for its high test and uniform quality"

MICHIGAN ALKALI CO.

General Sales Department

10 East 40th Street, New York City

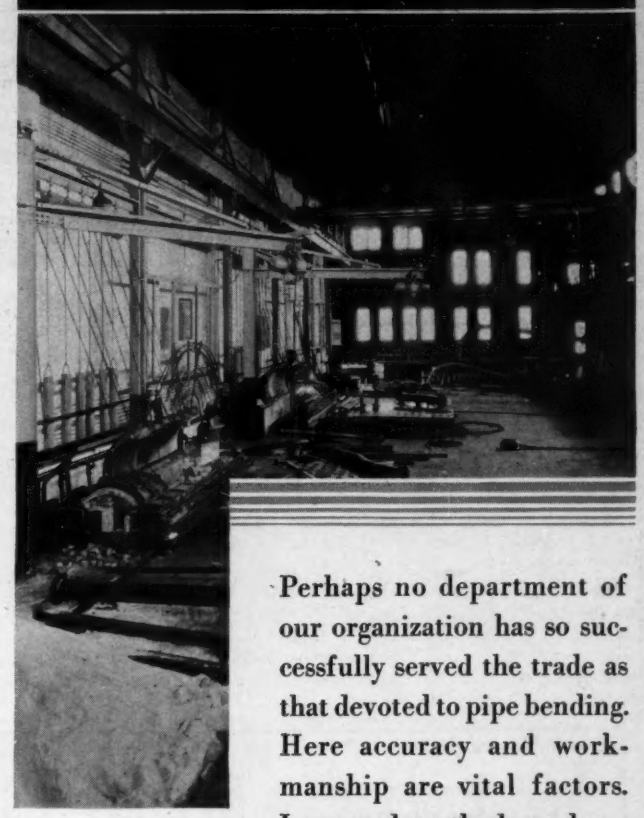
Chicago Office: 1316 South Canal St.

Works: Wyandotte, Mich.

Also Manufacturers of Soda Ash—Calcium Chloride—Bicarbonate of Soda

NOTE NEW ADDRESS: Our new location in New York is at 10 East 40th Street — just across the street from where we were and a few steps nearer Fifth Avenue.

PIPE bends



Showing a corner of pipe-bend department

Perhaps no department of our organization has so successfully served the trade as that devoted to pipe bending. Here accuracy and workmanship are vital factors. Improved methods and expert shop procedure enable us to meet your specifications with a degree of exactness and dispatch so highly essential. But no matter what —a bend, a fitting, a welded job, or a complete fabrication —put it up to

POWER PIPING COMPANY
PITTSBURGH, PA.

Power Piping
FOR EVERY INDUSTRIAL NEED

North American Refractories Company announces the purchase of the assets, good will and business of the United States Refractories Corporation, of Mt. Union, Pennsylvania, and the Savage Mountain Fire Brick Company, of Allegany County, Frostburg, Maryland. With their addition, North American Refractories Company is in a position to supply all grades of refractories, produced by every known process, from raw materials in Pennsylvania, Maryland, Ohio, Kentucky and Missouri.

This purchase completes the already extensive North American line by adding a fine silica brick made in one of America's most modern and efficient plants—a plant with a capacity of 40,000,000 brick a year. It also adds to the family of North American products the Savage Mountain fire brick.

The entire organization of these concerns, headed by President Thomas N. Kurtz, becomes part of the official North American family. Temporarily the management and sales of those companies will be handled as heretofore from Mount Union, Pennsylvania, as a division of North American Refractories Company.

Walworth Company, Boston, has issued Catalog No. 88, with 754 pages devoted to listing and describing Walworth valves, fittings and tools. This catalog has 23 pages devoted to a general index in the back, with a double-page layout in the center of the book devoted to a brief indexing of equipment by classes, is conveniently located by a slotting of the center pages.

The catalog is begun with a showing of bronze valves with the idea of giving most prominence to the quality products of a more distinctive type. On all valves recommended for oil, water and gas service, the ratings are given. Throughout the book is carried text matter giving the salient sales points of the more important items. At the beginning of the steel section is shown a steel valve and fittings recommendation chart, covering pressures, temperatures and trip materials for various classes of service.

The color scheme, the binding of the book, the topography and the size of the pages combine to make a very attractive layout.

Republic Steel Corporation's new plant devoted to the making of electric weld pipe, has made available a new kind of welded pipe.

An experimental mill making only small sizes has been in production for almost a year with the result that over 2000 miles of pipe were placed in service. The many advantages of this pipe were so apparent that the demand created made necessary the building of a completely equipped new plant for making sizes from 4½ to 16 inches in diameter.

Some of the advantages claimed for Republic electricweld pipe are: Guaranteed 100 per cent efficiency of weld, uniform wall thickness, perfect roundness, uniform strength and resistance to corrosion, freedom from flat spots, scale and oxide free and smooth finish.

Neilan Company, Ltd., Los Angeles, manufacturers of pressure control equipment, has opened a branch office in San Francisco at 16 Avila Road. Wm. S. Waldrip, who has been with the firm several years, is to be in charge of the San Francisco branch.

General Refractories Company announces the opening of a new district sales office in Birmingham, Alabama, July 15, located in the Empire Building and in charge of Walter S. Stapler.

James B. Sipe and Company, paint manufacturers and engineers, Pittsburgh, has appointed Fred Devenney as district representative at Tulsa, succeeding F. W. Gumaer, effective August 1. The Tulsa office is located at 8 North Cheyenne Street. The company continues to stock Sipes paint products with the Tulsa Terminal Storage and Transfer Company.

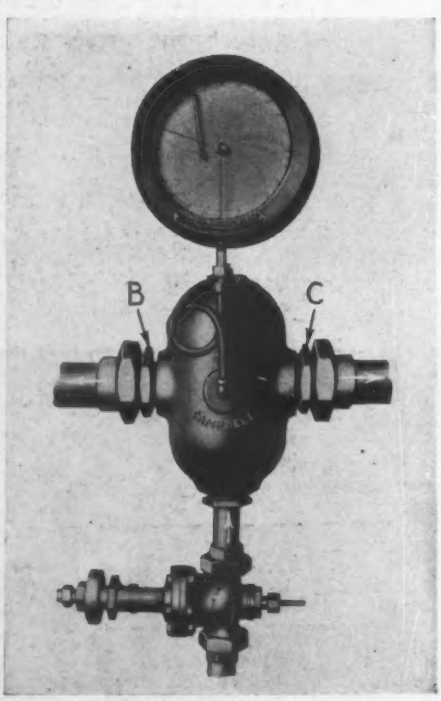
J. B. McMahon, formerly Tulsa branch manager of The Foxboro Company, will hereafter make his headquarters at the home office at Foxboro, Massachusetts. He has taken charge of all field engineering service and is in charge of direct sales. G. B. Lane, formerly manager of the Detrtoit office, has succeeded McMahon as branch manager at Tulsa.

Webster Engineering Company, Tulsa, a subsidiary of Surface Combustion Company of Toledo, has taken over the sales and distribution of the Natural Gas Equipment Company's products in the territory outside the Pacific Coast area. Likewise Natural Gas Equipment Company takes over the sales and distribution of Webster Engineering Company products in the Pacific Coast territory.

Headquarters of Natural Gas Equipment Company are in Los Angeles and V. E. Ready, who has been in charge of the Tulsa office of the company, will serve with Webster Engineering organization handling the Wilgus regulator business for the Natural Gas Equipment Company.

Products of Webster Engineering Company include the Webster radiant low pressure burners and Merit damper control system of heating. Besides the Wilgus regulator the products of the Natural Gas Equipment Company include the Anubus orifice meter and the N. G. E. high pressure gas burner.

Install CAMPBELL Controllers NOW!

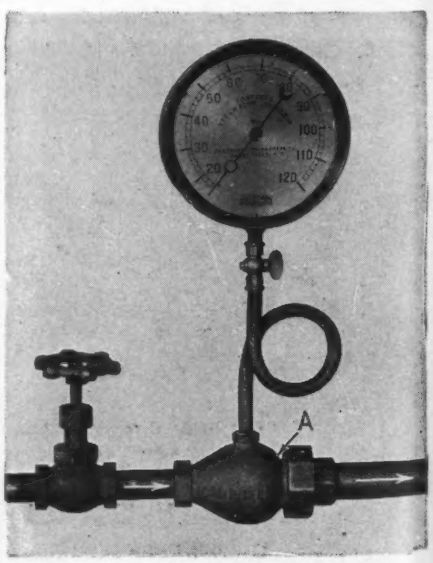


This is the "Watermelon Type." Controls simultaneously through two orifices, B and C. Records, indicates, and controls.

NOW is the time to install CAMPBELL Controllers. The time to begin effecting economies is TODAY. These Controllers are being used by many of the largest refineries. We will gladly furnish you with a partial list so that you can investigate the merits of our remarkable devices if you wish.

CAMPBELL Controllers are scientifically designed to control, indicate, and record the number of pounds of steam per hour used by any still. Flow rate is quickly varied at will. Very rugged. Easily installed. Readily understood by any operator. Wherever there is steam pressure drop to any refinery process work, the Campbell controller is applicable.

We also manufacture the TAR BABY BURNER, to handle Fuel Oils, Water Gas Tar, Acid Sludge, and Residue Fuels.



The "Pumpkin Seed Type." Control orifice is at A. Also records if desired.

Fill in, Tear off, and Mail

THE CAMPBELL ENGINEERING CO., 282 South St., Newark, N. J.

Without obligating us in any way, please send list of names of users of ☐ the Watermelon Type, ☐ the Pumpkin Seed Type, ☐ the Tar Baby Oil Burner.

Name ..... *Firm* .....

Address .....

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For Accurate Measurement of Oil at any Stage of Refining, Shipping, Storage or Selling.

The EMPIRE

A Positive Displacement Oscillating Piston Design

Highly accurate. Strong and durable. Easy to install. Economical to maintain. Simple to operate. Requires no complicated servicing. Made in all sizes, from 5/8" to 6", in standard (150 lbs. working pressure to square inch) and high pressure (300 lbs. and up) types.

Send postal for fully descriptive pamphlet 125-R.

The EMPIRE is different from every other type of meter offered for oil measuring work. The action of its measuring unit is a gentle, almost floating motion, with balanced pressures and a minimum of friction. This unique design enables the EMPIRE to hold its original high accuracy under operating conditions that quickly destroy the value of other types.

National Meter Company

299 Broadway, New York
Branches in all principal cities.

Facts About Firebrick Joints

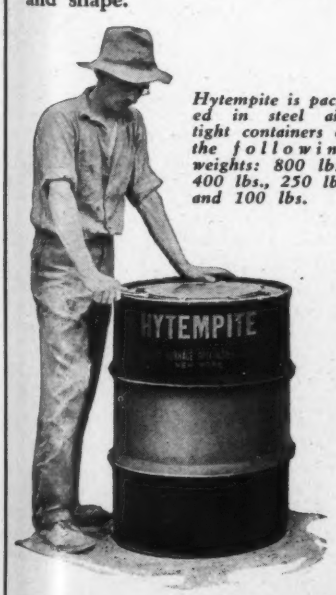
Fourteen years ago we strongly urged the use of a thin cement joint for firebrick construction in place of the thick fire clay joint which was then the general practice.

Today the thin joint is generally recommended by firebrick masons and firebrick manufacturers as they now produce high quality brick and tile that are true to size and shape.

Select the brick best suited to your needs, bond them with HYTEMPITE and you make certain the best refractory service.

HYTEMPITE joints do not erode as there's practically no joint—just a brick to brick surface throughout the structure—*No Shrinkage —No Cracks—No Leakage.*

Thick joints of Hytempite mixed with crushed fire brick can be used when the lack of uniformity of brick makes a thick joint necessary.

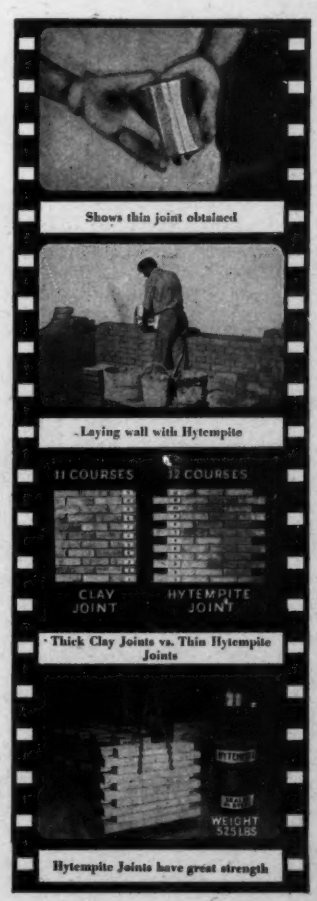


Hytempite is packed in steel air-tight containers of the following weights: 800 lbs., 400 lbs., 250 lbs. and 100 lbs.

QUIGLEY GAS-TITE BAFFLES

for boilers and stills are made of crushed old firebrick bonded with Hytempite. This mixture is either tamped in place against a lattice-work form or "shot" with the Quigley Refractory Gun. They are now installed in boilers with a total capacity of over 500,000 B.H.P.

Ask for Folder BR 136.



QUIGLEY FURNACE SPECIALTIES COMPANY INC.

56 West 45th Street New York

REFRACTORY MATERIALS FOR FURNACE CONSTRUCTION AND MAINTENANCE
ACID PROOF CEMENTS ACID AND ALKALI PROOF COATINGS

Stock and Service through Agents in Every Industrial Center

CHERRY RED

The old timer burned his used fullers earth "cherry red," whatever that is. That was guessing. Nowadays earth is revivified by heating for a definite time at a definite temperature, with constant stirring. This is done with the Nichols Herreshoff Furnace. It eliminates guessing. Naturally, the output is uniform, higher in efficiency and longer in life.

G. G. Brockway Company, Inc.
WARREN, PA.

F. L. KALLUM

Foster Wheeler Corporation, Los Angeles, announces that F. L. Kallum has recently joined its staff. He is attached to the Los Angeles office and is chief engineer of the gasoline absorption and stabilizer departments.

Mr. Kallum is well known in the natural gasoline field, having been formerly connected with C. F. Braun & Company, Shell Oil Company, Pan American Petroleum Company, Southwestern Engineering Corporation and others. During the past few years he has written many technical articles on the subject of natural gasoline manufacture and practice and theory of heat exchange.

Mr. Kallum received an A.B. degree at Stanford in 1921 and a Mechanical Engineering degree in 1922. His article on "Thermal Conductivity of Liquids" while in Standford secured him a membership in the Sigma Xi honorary society in 1922, and the same paper won the ASME junior prize in 1923.

Mr. Kallum is an active and contributing member in the American Chemical Society, the American Institute of Chemical Engineers, the American Society of Mechanical Engineers, the American Petroleum Institute, and the California Natural Gasoline Association.

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BROOKLYN, N. Y.

The Fluor Corporation, Ltd., 909 East 59 street, Los Angeles, contractors for compression and absorption plants and all types of heavy construction, has recntly been awarded the contract to build a series of compressor stations on the new natural gas line extending from the Texas Panhandle to Indianapolis. The job is for the Missouri Kansas Pipe Line Company and involves approximately $1,500,000.

According to P. E. Fluor, vice-president and general manager of the Fluor Corporation, the stations will have a discharge pressure of 450 to 500 pounds. The first station is to be located at Liberal, Kansas, and will have four 1000 horsepower units. The Fluor Corporation is building all office buildings and employees' residences, as well as an absorption plant at the Liberal station.

The second station will be located at Louisburg, Kansas, and the third at Louisiana, Missouri. Both of these will have six 1000 horsepower units. Work has been started on all three of them with D. W. Darnell in charge of the field work, with a force of about 350 men employed. The first station is expected to be completed by October 15th, the second November 15th, and the third December 15th, 1930.

The Borden Company, Warren, Ohio, announces that it will now carry in stock dies for all sizes of "Beaver" tools, specially ground for threading brass pipe, due to the constantly increasing use of brass pipe. For easy identification these dies will be copper plated, and stamped "For Brass Pipe." They will be available in supply houses.